COMPRESSED AIR

AND EVERYTHING PNEUMATIC.

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THE SOUTH AFRICAN MINES DRILLING CONTEST

The labor problem of the South African gold mines, or "on the Rand," has been for some time most serious and urgent. The deportation of 53,000 Chinamen left the colony with a labor supply deficient both in quantity and quality. A machine substitute for the former hand drill became an imperative necessity. A stope drill of some sort which, if operated in sufficient numbers could drill 100,000 3 foot holes per day, was urgently needed. These holes if drilled by hand would cost, roughly, $100,000, so that there was and is an immediate market for 2,000 to 5,000 stope drills when there is a practical assurance of their efficiency and reliability. Ten or twelve different makes of drills had been offered to the industry within a year, but still all was confusion as to their merits and in the ordinary course of events it would have taken probably years to decide which was best or near best.

In this contingency, to assist all concerned in arriving at a satisfactory conclusion in regard to the work of the drills offered, *South African Mines,* a most enterprising and worthy technical publication, proposed a formal contest, offering to the winning drill a trophy costing $500, the award to be made upon the aggregate depth of holes drilled in a given time, the only other condition being that the drill should be a one man drill. The competitors were to be at no expense other than the furnishing of their own drill and equipment, and a competent operator in each case.

The contest proposed was accepted and every preparation was made for a carefully conducted and absolutely fair trial. An advisory board of 16 men of the highest standing was selected and under their advice the preliminaries were outlined. The competition having assumed greater proportions than ever anticipated by the promoters, the entire mining industry having interests in one way or the other to be much affected by the result, the advisory committee was finally increased to 72. The Lord High Commissioner of the colony, Lord Selborne helped the affair untiringly, the character and extent of his interest being perhaps best shown by the half-tone herewith, in which he appears in the foreground actually operating the Gordon drill used in the underground contest.

Professor Orr was the judge of the surface contest and Professor Yates of the underground, both of whom presented elaborate reports with complete tabulated records of the entire contest. These reports it is, of course, entirely impossible to reproduce or even satisfactorily to abstract, but the results are very simply stated. The Gordon drill was so pronouncedly the leader all through and the triumphant winner at the end that there was not a word to be said. The record of the contest is unique in that there was not the slightest

dispute, protest or misunderstanding throughout the entire proceedings.

A WELL DESERVED VICTORY.

Before the final reports of the judges were available *South African Mines* said:

"We are advised by both judges that the winner is the 'Gordon,' and that whatever positions may be assigned to the other competing drills, when results are compared in detail, no doubt exists regarding the pre-eminence of the victor. The winner is well deserved and popular; indeed, the highest tribute that has been paid to the searching character of the conditions under which the contest was carried out is the unanimous concensus of opinion that the best drill has won. The fine performance of the 'Gordon' was the feature of the contest. Not only did it beat all the others, and beat most of them by a substantial margin, but it fulfilled the claim of its owners and makers in a manner surprising to those of us who are familiar with the frequency with which the promise of a stope drill outruns performance. Underground the superiority of the Gordon was most marked. Alone of all the competitors it performed the full allotted task. Its lightness, portability, and water-feed attachment gave it an immense advantage.

"The more the conditions assimilated to actual mining practice, the more the Gordon drew ahead. On the surface, in the four granite blocks, it was merely the drill that did the most work in the stipulated time; amid the difficulties underground it was the drill, *and the only one,* that drilled all the time."

CONDITIONS OF THE SURFACE CONTEST.

Four granite blocks approximately 5 by 3 by 3 feet were conveniently placed, three of them with the front face inclined 25 degrees back from the vertical. Each drill was required to drill one hole in each block. The holes drilled in blocks A, B and C were to be wet holes drilled at right angles to the face. Dry holes were to be drilled in block D, the first and third to be horizontal and on the right side of the column; the second hole on the left hand side to be drilled at an angle of 10 degrees above the horizontal. These holes are always referred to by the drillers as dry holes, that is, holes into which water cannot be poured, but it was within the province of any competitor to supply water if his machine was specially designed to do so. No independent spray apparatus was admitted.

The trials began promptly each morning at 8:30. Each contestant was to do one hour's drilling in each of the three blocks, A, B and C, and one hour's dry drilling in block D. A pause of one quarter of an hour took place between leaving one block and column and starting on the next. During the three intermissions nothing could be done by the contestants to their machines other than to take them off one column and place them alongside the next column. There were two series of tests like this for each contestant, the first day's trials being at an air pressure of 50 lbs., and the second day's trials with the air at 60 lbs.

Suitable columns, rigidly erected, were furnished, with a column arm on each, column clamps being furnished by each contestant. The contestant might locate the column in a suitable position for drilling before the trial began, but could not adjust the arm or clamp. The drill itself was to lie three feet away from the column. At least one hole was to be drilled on each side of the column during each run on each block, each hole not less than 36 in. deep nor more than 45 in., and for each hole a change in the position of both the arm and the column clamp. A 50 ft. length of ¾ in. air hose was used, the machine end of the hose being disconnected before beginning work on each of the blocks. Each operator had a roped in space in front of the block 8 by 8 feet, only two contestants working each day.

CONDITIONS OF THE UNDERGROUND CONTEST.

The underground trials were held in a stope which dips about 25 degrees and is about 7 ft. wide. The underhand bench used for down holes was about 30 ft. long, and furnished a working face 4 ft. 6 in. to 5 ft. wide, all in banket. The bench for the test on dry holes was about 30 ft. further east. The face at that point was about 4 ft. 6 in. wide, about 18 in. of which was sandstone, the rest banket. This face was also about 30 ft. long, in which distance it rose about 9 ft. in height.

The more important conditions governing

the drilling of the holes were that eight dry holes should be drilled on one bench one day, and eight wet holes on the other bench the next day; each hole should require a change in position of both the arm and the column clamps; not more than two consecutive holes should be drilled on one side of the column, and not more than four holes from one set-up. After the holes were drilled, the machine, the bar and everything but the drill steel had to be returned to the place in the drift whence they had been taken when the test started. All holes had to be drilled following as near as possible the angle of dip of the banket, no holes to be less than 36 in. nor more than 45 in. long. Each competitor was allowed one spare machine.

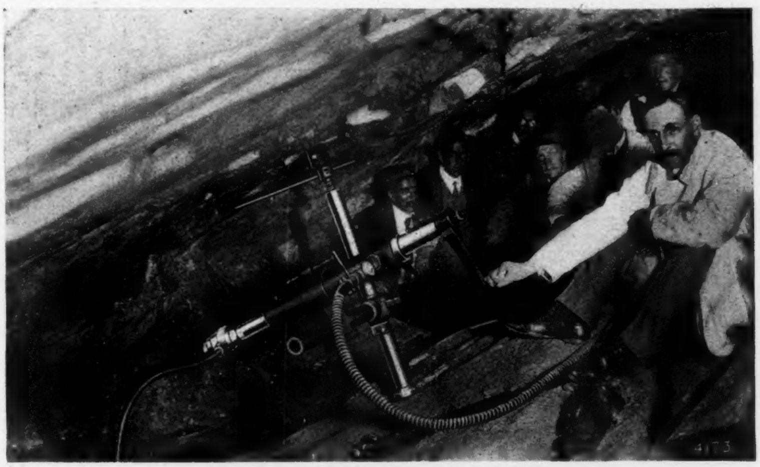
RESULTS.

The following is condensed from the summary of results prepared by *South African Mines*:

Nine drills competed, five with reciprocating pistons and four of the hammer type, the weights ranging from $44\frac{1}{4}$ to 129 lbs. The winning drill weighed 72 5-8 lbs; other drills are given in Table 1.

AS TO ONE MAN MACHINES.

The conditions were framed throughout for a one man drill competition, but not all the drills competing could be considered as belonging to the class. Several of them have usually



"GORDON" DRILL IN THE SOUTH AFRICAN DRILL CONTEST BEING OPERATED BY LORD SELBOURNE, GOVERNMENT HIGH COMMISSIONER.

No allowance was made for lost time except in case the air pressure fell below the specified pressure of 60 lbs. Two bars were furnished, one 2 ft. 6 in. closed, and the other 3 ft closed, and sufficient wedges and blocks were supplied for making a set-up quickly. Star and chisel bits had to be used for all eight holes; 60 drills were allowed. The bit of the 36 in. steel could not measure less than $1\frac{1}{4}$ in. The steel for deeper holes had to have a bit at least $1\frac{1}{8}$ in. The test was determined by the number of inches drilled in the length of time expired between the taking of the drill from and the return of it to the drift. Water was furnished to the machines in whatever manner desired.

Name of machine.	Type.	Diameter of of cylinder. ins.	Length of stroke. ins.	Length of feed. ins.	Weight. lbs.
Kimber ...	Hammer ...	$3\frac{1}{8}$	3	12	100
Little Wonder .	Reciprocating piston	2	6	10	$118\frac{1}{4}$
Gordon ...	Hammer ...	1 3/16	10	10	$72\frac{5}{8}$
Little Kid ...	Reciprocating piston	2	5	18	$102\frac{1}{4}$
Baby Ingersoll	Do.	$2\frac{1}{4}$	5	15	$129\frac{1}{4}$
Flottmann ...	Hammer ...	$2\frac{5}{8}$	$1\frac{3}{4}$	24	$52\frac{1}{4}$
Hardsocg	Do ...	1 8	$1\frac{5}{8}$	18	$44\frac{1}{4}$
Little Holman	Reciprocating piston	2	5	16	$97\frac{3}{4}$
Chersen ...	Do.	$2\frac{1}{4}$	6	18	$113\frac{3}{8}$

TABLE 1, DETAILS OF COMPETING DRILLS.

had an unskilled colored laborer to rig up and take down the drill and column, and a white man either to supervise the running or to operate it himself. On the Rand economy of labor is of superlative importance and the

strictly one man drill represents a great annual saving in operation when compared with the drill which requires two or three operators or assistants. Other things being nearly equal

Name of Drill.	50 lbs pressure. Depth drilled.	50 lbs pressure. Time taken.	50 lbs pressure. Inches per minute.	60 lbs pressure. Depth drilled.	60 lbs pressure. Time taken.	60 lbs pressure. Inches per minute.
	Inches		Inches			
Kimber ...	155⅜	4 hrs	0·64	203	4 hrs	0·8
Little Wonder (tappet) ...	199⅞	4 hrs	0·83	239⅞	4 hrs	1·0
Gordon ...	340⅜	4 hrs	1·42	441¼	4 hrs	1·84
Little Kid ...	189⅜	4 hrs	0·79	270⅛	4 hrs	1·12
Hardsocg ...	11¾	95 min	0·12	—	—	—
Baby Ingersoll	302	4 hrs	1·26	353	4 hrs	1·47
Flottmann ...	226⅜	4 hrs	0·94	302⅝	4 hrs	1·26
Little Holman	170⅝	4 hrs	0·71	202¼	4 hrs	0·84
Chersen ...	315	4 hrs	1·31	396¼	4 hrs	1·65

TABLE 2, RESULTS OF SURFACE CONTEST.

speed of drilling is of the first importance. However low the air consumption, or however little the cost of up-keep these things cannot count unless holes of good depth are drilled in reasonable time. The winning drill was the only machine which completed the task set. At the surface all the competitors with the exception of the Hardsocg ran for four hours

Name of Drill.	Wet Holes. Depth drilled.	Wet Holes. Time taken.	Wet Holes. Inches per minute.	Dry Holes. Depth drilled.	Dry Holes. Time taken.	Dry Holes. Inches per minute.
	Inches			Inches		
Little Wonder (tappet) ...	211¼	3' 7·5 min	0·68	—	—	—
Gordon ...	306½	168 „	1·82	312	179 min	1·74
Little Kid ...	277	338¼ „	0·82	36	289 „	0·12
Baby Ingersoll	293½	253 „	1·16	192⅜	360½ „	0·53
Flottmann ...	77¼	137 „	0·56	—	—	—
Little Holman	352	291 „	1·21	78¼	245 „	0·32
Chersen ..	319⅞	223 „	1·43	77⅞	288 „	0·27

TABLE 3, RESULTS OF UNDERGROUND CONTEST.

both with 50 and 60 lbs. air pressure, although one or two machines were constantly in difficulty.

Underground the real practical value of the stope drills was determined. The conditions were: The drilling of eight holes in a wet or underhand stope, and eight in a dry or overhead stope, each hole to be not less than 36 in. deep. The Gordon drilled the 16 holes in 5 hours 47 min. The Chersen drilled 12 holes in 8 hours 29½ minutes, and the Baby Ingersoll did 13 holes in 10 hours 13½ min.

Tables 2 and 3 summarize the results, the former at the surface and the latter underground.

A number of interesting things are to be gathered from table 4. in which the total time is compared with the actual drilling time, the difference indicating the proportion of the time employed in setting up and making the required changes. This table besides establishing the relative handiness of the different drills also throws a most interesting light on the question of air pressures. This was a lesson especially needed in all the South African mines, where the prevailing pressures have been, as compared with practice elsewhere, absurdly low. The importance of the matter is shown by the contrast between the inches drilled per minute of actual running time with

Name of Machine.	50 lbs pressure. Inches drilled per min. of total time.	50 lbs pressure. Inches drilled per min. of actual running time.	50 lbs pressure. Percent'ge actual running time is of total time.	60 lbs pressure. Inches drilled per min. of total time.	60 lbs pressure. Inches drilled per min. of actual running time.	60 lbs pressure. Percent'ge actual running time is of total time.
Kimber ...	0·64	1·06	60·7	0·8	1·6	50
Little Wonder...	0·83	1·17	70·9	1·0	1·45	68
Gordon ...	1·42	1·65	86	1·84	2·14	86
Little Kid ...	0·79	1·08	72·5	1·12	1·47	76·6
Baby Ingersoll .	1·26	1·64	76·7	1·47	2·06	71·3
Flottmann ...	0·94	1·55	60·9	1·26	1·69	72·0
Little Holman .	0·71	0·88	80·3	0·84	1·07	78·4
Chersen ...	1·31	1·74	75·3	1·65	2·14	77·1

TABLE 4, TOTAL TIME AND ACTUAL DRILLING TIME,

50 lbs. air pressure and the number drilled at 60 lbs.

The higher efficiency of the then leading drills at the higher pressure was as follows:

Gordon..........................30 per cent.
Chersen........................23 per cent.
Baby Ingersoll...............25½ per cent...

These calculations are, of course, all based

Name of Drill.	At Surface. Inches drilled.	At Surface. Time drilling—min.	Underground. Inches drilled.	Underground. Time drilling—min.	Av. inches per min. over full four days' run.
1. Gordon ...	781·875	480	618·5	347	1·69
2. Chersen ..	711·25	480	397·25	509·5	1·12
3. Baby Ingersoll .	655	480	485·75	613·5	1·04
4. Flottmann ...	529	480	77·25	137	0·98
5. Little Wonder...	439·25	480	211·25	307·5	0·83
6. Little Holman...	372·875	480	430·25	536	0·79
7. Little Kid ...	459·5	480	313	627·25	0·69
8. Kimber ...	358·375	480	—	199	0·52

TABLE 5, AVERAGE OF TOTAL WORK.

on completed holes only, no hole less than 36 inches nor any portion of a hole over 45 inches being counted.

DRILL STEELS.

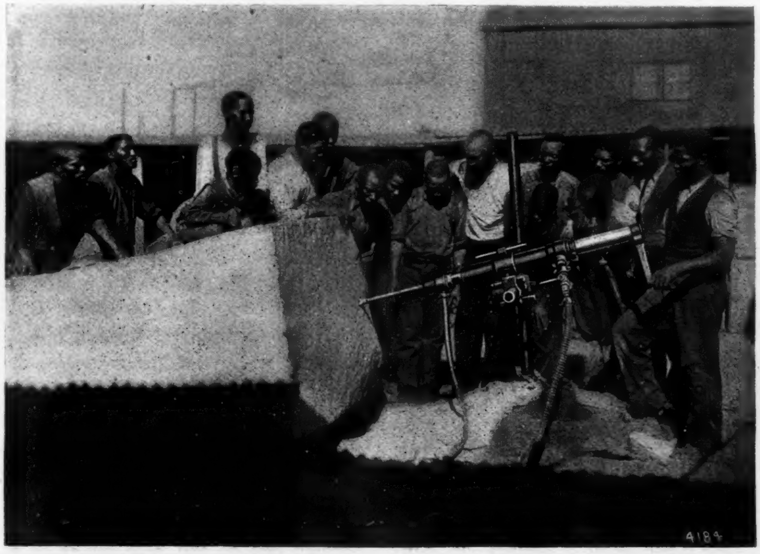
Of the nine drills competing five had considerable trouble with their drill steels, one or two machines retiring from the contest on this account. The failure of certain machines underground was, however, really on account of their inability to drill dry holes.

PREVENTING MINER'S PHTHISIS.

Another point of interest in the contest not only to the medical man, but to all connected with the mining industry was in its bearing upon the problem of arresting the evil of miner's phthisis. The Gordon drill method of wetting the holes by feeding water through hollow steel was a novel and striking feature. It was thought that it should do more in ridding the Rand of this pestilential disease, than all the commissions that have sat and all the respirators and atomizers ever invented.

AS TO THE OPERATORS.

Of course there was a difference in the operators of the different drills. Mr. Frank Crean, who ran the Gordon proved himself a most efficient workman and it is only fair to him to say that had the Gordon been in less skilled hands it would not have done as good work. On the other hand, says *South African Mines,* we should be doing the drill—which is essentially a "fool proof" machine requiring from the runner extremely little practice to be able to operate it successfully—a great injustice if we attributed the success of the drill to the dexterity of its operator. A native operator shortly before this trial ran the machine in regular mining work and obtained results which conclusively proved that the Gordon is not a drill for skilled operators only, but can render most efficient service with any average Rand mine "boy."



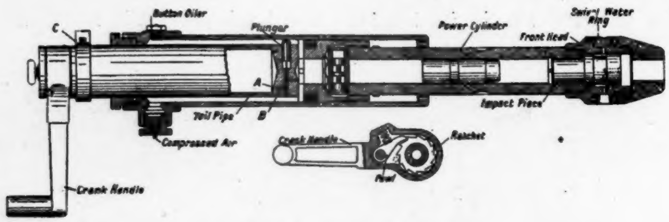
BOY MALAMBA DRILLING WITH GORDON DRILL AS MUCH AS ALL THE ONLOOKERS WORKING BY HAND

DESCRIPTION OF THE GORDON DRILL.

The construction and operation of this drill is easily understood by reference to the cut on the following page; and the most evident feature of it is its simplicity. This will appeal especially to the man of the shop familiar with the building of drills. It appears at once that there are no parts of such intricate shape as to call for castings. Every part can be and is made of forged steel of the precise quality best adapted to the specific function of that part. All parts

are machined all over, and there is every opportunity for the most accurate fit and the finest finish of surfaces, all parts requiring it being hardened, and the fits being made by grinding to micrometric gauges.

The barrel or shell of the drill is round and is held in a round clamp, so that in setting it it can be turned and slid to the most satisfactory position before clamping, and then it can be clamped with absolute security. The tail pipe slides in the barrel with a cup leather packing at the rear. The space between the tail pipe and the barrel being filled with air at the working pressure, this pressure acts against the annular surface exposed to it at the head of the power cylinder, driving that constantly forward and pressing the steel bit against the rock. The drill therefore always feeds or drives the power cylinder forward when the pressure is on, and the runner has nothing to do with it and never has to think of it.



SECTION OF GORDON DRILL

The tail pipe is fastened to the rear end of the power cylinder so that they turn or move longitudinally together. The power cylinder has a front head and to this in turn is secured a nose or end piece with a square or hexagonal hole into which the end of the steel bit is inserted. The rear end of the tail piece has a ratchet and a crank which is turned usually slowly but quite constantly while the drill is in operation, this turning the power cylinder and the bit in the rock. The use of the ratchet compels the runner if he turns the crank at all to turn the cylinder and bit all the way round and not merely move it back and forth. The tail pipe serves as an oil reservoir and the oil may be poured in at the centre of the crank end. A little plunger is shown which slides in a side hole in the solid forward end of the tail pipe. There is a small tail or stem *B* on the inner end of this plunger, and a spring *A* forces the stem and plunger outward so that normally the plunger touches the inside of the shell as shown. When the machine is in operation the oil in the tail pipe passes through the small hole and fills the space below the plunger. When the tail pipe and cylinder are drawn back to insert a fresh bit the plunger is forced inwards when it strikes the beveled shoulder and enters the part of the shell which fits the tail pipe. This forces the small amount of oil in the space below the plunger out through a second small port into the space immediately behind the valve, from which it is carried along by the air to lubricate the valve and piston.

When drilling "up" holes the oil will not flow into the space below the plunger and in such cases the oil must be inserted at intervals through the bottom oiler, from which point it is carried along by the air and keeps every working part oiled.

The forward end of the casing is made a loose sliding fit on the power cylinder while forwardly directed ports permit the escape of exhaust air from the forward end of the casing in a direction which prevents mud thrown out of the hole which is being drilled from flying into the face of the operator.

The adjustable collar *C* may be tightened on the tail pipe at any point, thus forming a stop, after which the tail pipe can only advance until the collar comes in contact with the gland just in front of it. This is chiefly used to keep the machine back when changing bits, while drilling steep down holes or when transporting the machine to prevent sliding. When the tail pipe is drawn clear back the machine is, of course, no longer over all than in any other position.

On the forward end of the machine is mounted a swivel water ring, to which is attached a hose leading from a water supply with a slight pressure. Leather packing rings prevent the escape of water from the sides

of this swivel ring. The water entering the swivel ring from the attached hose passes through holes in the front head and impact piece and thence through a central hole extending the entire length of the drill steel to the bottom of the hole in the rock. The impact piece receives the blows of the piston and transmits the force to the drill steel. This impact piece also serves to keep grit out of the cylinder when the machine is not in use, and as a means of introducing water from the swivel to the central hole in the drill steel.

It is not necessary to describe in detail the valve motion. The drill belongs to the family of "pneumatic tools," the work being done by the rapid blows of the piston upon the impact piece. The piston always starts when the pressure is turned on and it continues working as long as the pressure is maintained.

CLAIMS MADE FOR THE DRILL.

Besides the actual results in work done under all the various conditions specified, the drill in itself completely satisfies the requirements. It is in every sense a one man drill. It is light, so that one man can easily move it and place it in every position required. It is simple in construction and operation so that an unskilled runner can do with it almost as much work as the most skilled, the actual speed of drilling being entirely independent of outside manipulation. Setting the machine and changing the steels is all that calls for any skill. It drills equally fast on up, down or flat holes. It may be operated in any stope which is wide enough to permit the operator to get around in. It has strength and durability due to the fact that all the wearing surfaces are of hardened steel. It is kept automatically oiled. Water is at all times delivered to the bottom of the hole, keeping the hole clear and the bits free. Most important of all, the water kills the dust, and association with this drill cannot produce Miner's phthisis. In the open air trials not a particle of dust was to be seen.

The trial of course decided only the one thing. The Gorden drill, as a one man drill, did much more work in aggregate depth of holes drilled then any other, did it on the surface and underground, in wet holes and in dry holes and at both of the working pressures employed. As to the wear of the drill there is strong presumption of its easy maintenance, of the air consumption there is no evidence and of the range of work to which the drill may be adapted there may be different opinions, but where it was tried and as it was tried it was a great success.

BREATHING HIGH MOUNTAIN AIR

Experiements which have been conducted in the Andes to determine the effects of the atmosphere at high altitudes upon the functions of the body have shown that at heights approximating three miles the air pressure is so light as to produce incapacity for work, prostration and sometimes death. The absolute air pressure being only about 60 per cent. of that at sea level, while the lungs may take in the normal volume of air for inhalation the actual weight of the inspired air, and therefore of the oxygen constituent of it, is proportionately reduced and, to make up for the deficiency, both the respiration and the heart action are automatically accelerated, while even at that the life functions are not fully sustained.

Professor Todd, the astronomer, of Amherst College, who is conducting experiments in South America, ascended a mountain in the Andes to an altitude of 14,000 feet, there experiencing the usual change of respiration and its accompaniments due to the diminished air pressure. While in this condition he entered an air receiver where the pressure was gradually increased to that corresponding to an altitude of 1,000 feet when his pulse was reduced from 104 to 91 and his breathing and general physical condition became entirely normal. A decompression of the air in the receiver to that surrounding it was made in seventeen minutes so that no serious consequences resulted from the experiment. The experiment is looked upon as important as bearing upon the treatment of diseases produced by protracted subjection to abnormal air pressures.

The Pittsburg Coal Company has practically decided to discontinue the use of black powder in the fifty-four mines of the company. Dynamite, or an explosive similar to it, will be substituted. It is claimed that black powder makes a longer and hotter flame than dynamite, and in "blow-out" shots is more likely to ignite pocket gas.

AUTOGENOUS WELDING

This process consists of heating the metal by a blow pipe using oxygen and acetylene gas. With this the metal is heated to the melting point and a steel rod is passed along with the flames, steel melting off from the rod and flowing into the point until it has been filled.

The flame is largely carbon monoxide but at the tip where the heating takes place it is converted into carbon dioxide. This gives a flame that will neither carbonize nor oxidize the metal. In lighting the blow-pipe, the acetylene is first turned on full, then the oxygen is added until the flame has only a single cone whose apex has a temperature of 6300 degrees Fahrenheit. Too much acetylene produces two cones and a white color, while an excess of oxygen is shown by the flame assuming a violet tint. The best welding results are obtainable with 1.7 volumes of oxygen to one of acetylene.

The oxygen for the process is obtained by using a special generator which has two lead-lined chambers with a scrubber and settling chamber between them.

In one chamebr is put a chemical charge of calcium compound and copper sulphate and the chamber filled with lukewarm water, after which the solution is stirred.

In the second chamber a solution of iron sulphate and water is poured. These two solutions produce a large quantity of oxygen which is passed through the scrubber into a receiving tank. The oxygen is drawn from this tank by an air compressor which compresses it to 147 pounds in a storage tank, from which it is taken through copper pipes to the point required.

The acetylene gas is manufactured in the ordinary way from calcium carbide, and used at a pressure of 2 or 3 pounds.

THE WELDING OPERATION.

Through a system of piping, the flame is easily carried to the work, which saves the labor of moving large pieces of work to a forge or hammer for welding. Pieces one inch thick have been successfully welded with this process, but its best application is in welding sheet metal, as joints of great length can be easily welded. In fact its only limit is the length of the joint and the time needed, and this latter can be carried out indefinitely.

Oxy-acetylene welding gives its best results in the welding of steel, but cast iron is being welded successfully as well as copper, brass and bronze. The different metals can also be welded together as is shown in Fig. 1 in which four plates were butted together and welded.

One plate was steel, as shown by the white square; another brass, as shown by the darker square in the diagonally opposite corner; and the two very dark squares were copper and bronze respectively. After welding these they were bent and broken at the joints to see if they were thoroughly welded, and from the appearance of the fractures they would indicate a perfect weld. The steel welded to the copper and bronze as well as the brass did. Owing to the high heat of the flame, however, the lead and zinc in the brass and bronze melted out leaving holes in the metal.

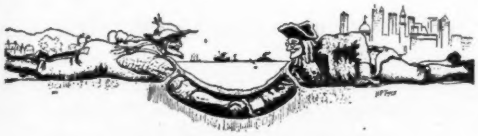
Welds of 90 per cent. efficiency can be made with careful workmanship and the cost in wages and gas for welding plates 1/8 of an inch thick is about 2 cents per foot.

A variation of this process has been made which cheapens the oxygen so that it can be made to cover a wider field of usefulness. This is the discovery of an oxygen powder which has been named "epurite." It is a substance containing oxygen in a latent state, and a form susceptible of easy liberation on contact with water. There is said to be no danger of explosion in connection with this process as there is no large quantity of gas stored in tanks under high pressure.

Oxygen and hydrogen are also being used in the proportion of from 2 to 4 parts hydrogen to 1 of oxygen, and the hottest part of this flame is about 3/8 of an inch from the point of the burner.

Two parts hydrogen to one of oxygen will give a flame with a temperature of about 4350 degrees Fahrenheit, but if a flame is desired with a reducing action it is necessary to use 4 parts of hydrogen to 1 of oxygen, and this will have a temperature of about 3450 degrees Fahrenheit. This flame will melt iron and cause it to weld even if the surfaces are not clean, as any rust present will be reduced.

This lower temperature of the flame is really better for sheets up to 1/8 of an inch thick, as the melting of the metal is less rapid and less explosive, giving a welded joint that is cleaner and with fewer scars and blisters.—*American Machinist.*

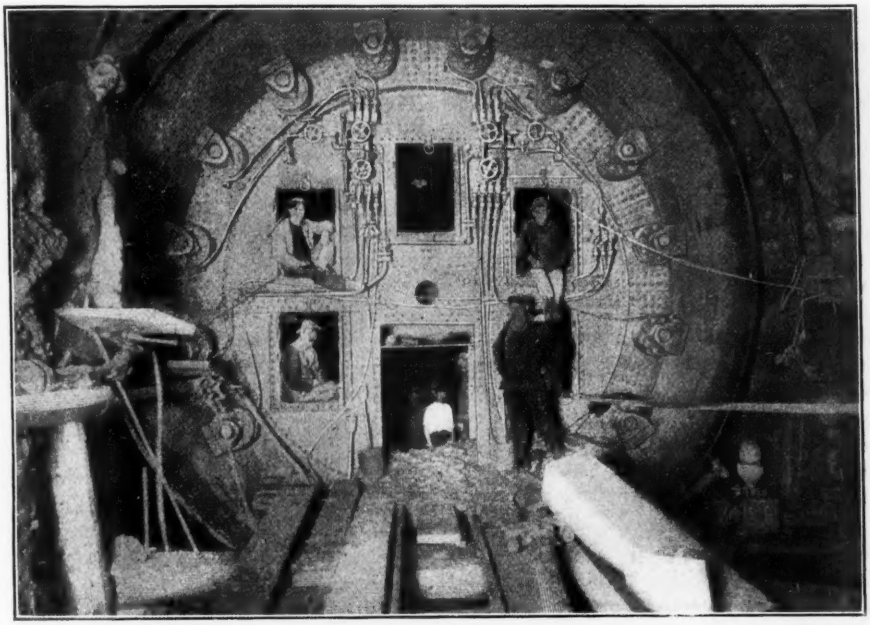


THE HUDSON-MANHATTAN TUNNELS

In our April issue we briefly alluded, editorially, to New York's Compressed Air Harvest, which the various subfluvian tunnels, fourteen in number, now completed or coming to completion so nearly together may properly be characterized. These may be considered a first crop, to be successively followed by others under the stimulus of the Metropolitan life forces; but in a periodical of the scope and dimensions of COMPRESSED AIR, it is quite impossible to speak even of this first crop as a whole. We, therefore, here have to do only with the Hudson-Manhattan, or, as they have come to be popularly known, the McAdoo tunnels.

The name McAdoo is synonymous with success in this case. A third of a century ago DeWitt Clinton Haskins started the enterprise and began the construction of a brick wall tunnel from both sides of the river. There was one very serious accident, and this with legal and financial difficulties paralyzed the undertaking. In 1902 the New York & New Jersey Railroad Company, under Mr. McAdoo began serious work. The next year this was merged with the Hudson & Manhattan Railroad Company, and later the "Hudson Companies" was formed to conduct the construction and real estate operations. Harvey Fisk & Sons have successfully financed the undertaking, and it is estimated that when the entire work is completed $70,000,000 will have been expended.

A little study of the accompanying map is necessary to a clear understanding of the ramifications and connections of this special system of tunnels, these alone being shown. The system as a whole may be considered in construction as consisting of four sections, only the first of which is as yet open to the public. This is the twin tube extending from Hoboken, N. J., near the D., L. & W. terminal, to Sixth avenue, New York. It enters Manhattan two blocks below Christopher street, and then passes up through the shipping district in Sixth avenue to Thirty-third street, near the front of the Pennsylvania Railroad station now under construction.



INNER FACE OF SHIELD—HUDSON MANHATTAN TUNNELS.

The south twin tunnels, which may be called

the second section, have been driven entirely from the Jersey side of the river, and are now completed to within a few hundred feet of the New York side. At Jersey City a large terminal station has been hewn out of the solid rock, eighty-five feet below the present station of the Pennsylvania Railroad. The tunnel station here is 150 feet long, with approaches 1,000 feet long, and great elevators reaching the surface. These tunnels enter New York between Cortlandt and Fulton streets, the station being surmounted by two of the largest and most magnificent office buildings in the city. This station also will connect with the present Subway at Broadway, only one block to the east.

The third section is a land tunnel parallel with the Hudson, connecting the Hoboken terminal with that in Jersey City, and also commanding the passenger stations of four trunk railroad lines which are now entirely dependent upon ferry service.

The fourth section, also a land tunnel, runs from the Jersey City terminal under the Pennsylvania station toward Newark. This tunnel passes under the most crowded portion of Jersey City, coming to the surface at the outskirts and the tunnel trains will then use the Pennsylvania tracks to Newark.

It will be noted that more than one half of this entire system is land tunnel, or, in Sixth avenue, typical subway, involving generally, no unusual difficulties; but the river tunnel work was among the most serious engineering ever undertaken and carried to success. On both the subterranean and the subaqeous work, compressed air was, of course, the great reliance.

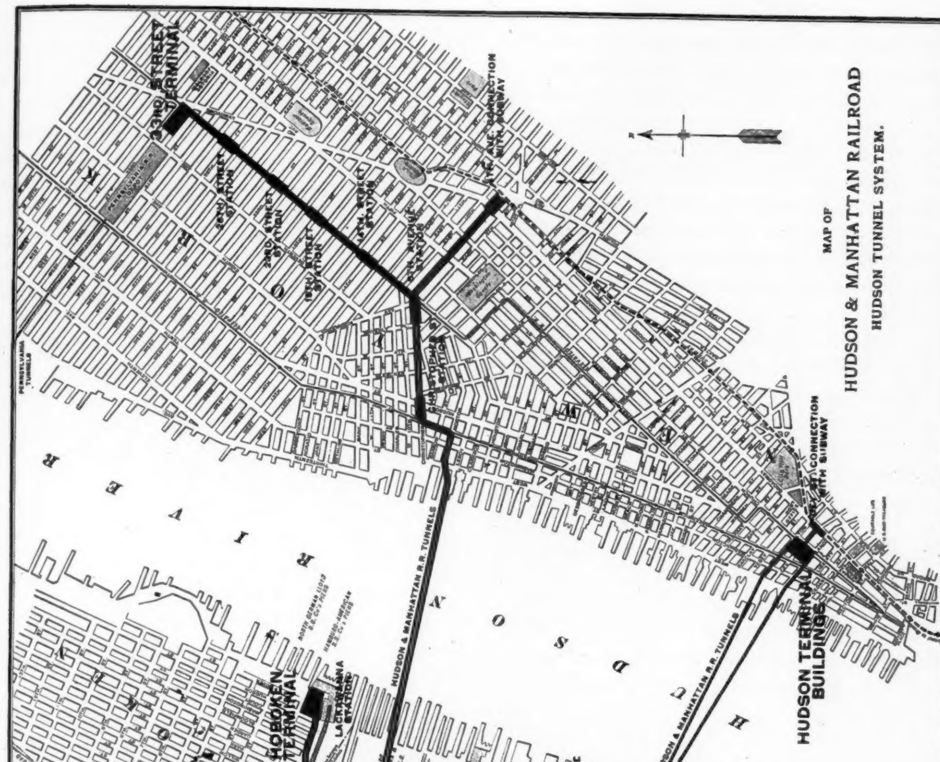
When the work was taken up anew by Mr. McAdoo, Mr. Charles M. Jacobs became chief engineer, assisted by Mr. J. Vipond Davis. The north tunnel had then been driven 3,800 feet from the New Jersey end. The shield which had been previously used in the work was continued, but with necessary changes, as it was then approaching a spur of rock which would make it necessary to drill and blast in advance of the shield. A heavy apron was added which extended 6 feet in advance of the shield, and under its protection the men were able to work and cut the rock. This work was done under an air pressure of 33 pounds, there being 14 feet of silt and 65 feet of water above. At times when blows occurred the river bed was blanketed with clay before operations could be continued.

In beginning the south tunnel, the other twin, changes were made in the tunnel design, and in the mode of procedure. The size was reduced to a diameter of 15 feet 3 inches in the clear. The cast plates bolted together insured the true circular section, and the shield could be manipulated to follow the exact alignment. An hydraulic erector was carried by the shield for placing the plates in position.

The shield was forced forward by 16 hydraulic rams with a total pressure of 2,500 tons. It was found that the shield could be thus forced forward, displacing the silt, without requiring any excavation. The cost of construction in consequence of this became much less than ever before attained in this class of work. By the original method 5 feet in 24 hours was considered excellent progress, while with the new method a record of 72 feet in 24 hours was made in one of the Cortlandt street tunnels.

Some interesting details of this undertaking are given in the words of Mr. Jacobs himself in the article which immediately follows this. In the North tunnels trains are now running regularly, carrying many passengers, with every indication that when the system is completed, and the anticipated connections are made with existing lines, it will be at once and continuously crowded to its full capacity. and the people will be clamoring for more.

The latest improvements have been incorporated in the new equipment. The cars are of steel, fire proof, have large sliding doors at the middle as well as at the ends, and the terminal station platforms are arranged for passengers to be entering and leaving the cars at the same time. The doors of the cars are operated by compressed air, and no signal bells are used. The automatic adjustment is such that not until the last door in the train is securely closed is it possible to give the electric flash signal to the motorman to start the train. There is a triple set of automatic devices for stopping the train. The ventilation of the tunnels takes care of itself in the most satisfactory manner. The trains in each tunnel run constantly in one direction, each train acts as a piston, forcing the air ahead of it with a fresh supply of air from the outside rushing in to take the place of the air expelled.



HUDSON COMPANIES' TUNNELS AND CONNECTIONS.

THE TERMINAL BUILDINGS.

The buildings which surmount the Cortlandt street terminal, extending from Cortlandt to Fulton streets, with Dey street between them, are in themselves another triumph of modern engineering. In business hours 10,000 persons will find constant occupation in them, and in the station below in the rush hours it will be possible to dispose of 1,000 passengers per minute. Before the superstructure could be begun an immense cofferdam inclosing the entire space of two city blocks, 420 by 192 feet, had to be sunk under air pressure to the depth of from seventy-five to ninety-eight feet below the surface, and the concrete foundations of all rest upon solid rock, none of the surrounding structures nor the traffic on the intervening and adjacent streets being stopped.

THE AIR COMPRESSORS.

It is interesting to note that the original Ingersoll air compressor installed at the Hoboken end of the first tunnel in 1880 was continued in service until the completion of the tunnels. This compressor was overhauled in 1890, and is rated as an Ingersoll, Class "A," with cylinders 20 and 20¼ by 30 inch stroke, free air capacity, 1,098 cu. ft. per minute, the other compressors comprising the plants of the three power houses responsible for the tunnel work of the Hudson Companies, all belong to the same family. Besides the compressor mentioned, the Hoboken plant included two Class "A" compressors, 22 and 26¼ by 24 inch stroke, free air capacity, 3,686 cu. ft. per minute, and one duplex Class "H" machine, 16 and 20¼ by 16 inch stroke, free air capacity, 2,178 cu. ft. per minute.

The Morton street plant at the Manhattan end of the same tunnels, comprised one duplex Road compressor, 22 and 22 by 24 inch stroke, free air capacity 2,640 cu. ft. per min., one Ingersoll Class "A" 22 and 22¼ by 24, free air capacity 1,320 cu. ft. per min., one 20 and 22¼ by 24, free air 1,320, and one 16 and 16¼ by 18, free air, 698.

At the Jersey City plant opposite Cortlandt street the compressors were three Ingersoll, Class H C, cross compound steam, two stage air compressors for high pressure air, and three Ingersoll, Class H, cross compound steam and duplex, single stage air for the low pressure air. The former were 14 and 28 inch steam and 24¼ and 14¼ air, by 16 inch stroke, free air capacity 4,710 cu. ft. per min., and the latter of the same steam cylinder dimensions with air cylinders 22¼ by 16 inch stroke, free air capacity 7,920 cu. ft. per min.

Supreme above all else in the complete ultimate success was of course the personnel. William G. McAdoo, a Tennessee lawyer, took up the project when it had twice failed and was by many regarded as a hopeless proposition. The discerning public permanently attaches his name as the familiar designation of what is now one of the City's permanent agencies of life and growth. Then there are others: Walter G. Oakman, president of the Hudson Companies; Pliny Fiske and William H. Barnum, financiers and bankers; Charles M. Jacobs, the alert, resourceful, experienced engineer, who is also consulting expert for the Pennsylvania tunnels; J. Vipond Davies, the partner and deputy of Mr. Jacobs, who has given more concentrated and continuous attention to the work in detail; L. B. Stillwell and Hugh Hazelton, electrical engineers; J. Van Vleck, mechanical engineer and Kenyon B. Conger whose responsibilities have had to do with the great terminal buildings.

The supreme continuous function of the system will be the conveyance of breadwinners of the Metropolis to and from their homes distributed over many miles and through the countless cities and towns of New Jersey, and it is not easy to say whether New York or New Jersey will be the most benefited. As to the enormous traffic secured it is only necessary to remember that perhaps three quarters of the passengers carried will be those who will each individually make over 600 trips per year.

TUNNEL ENGINEERING DIFFICULTIES AND EXPEDIENTS

The slight account in our April issue of the work of building the East River gas tunnel, fifteen years ago, bore testimony above everything else to the ready resourcefulness and constant push of Charles M. Jacobs, the engineer of that work. These characteristics are equally prominent in the following taken from a recent address by Mr. Jacobs, now chief engineer of the Hudson and Manhattan tunnels, before the Yale Club of New York.

IMPATIENCE MAKES WORK.

At the beginning of the work on the south

tube of the uptown tunnel, the shield from the Hoboken side was being advanced through the silt with the shield doors closed so as to save the cost of excavation. While the heading was still under the Lackawanna coal dock the night superintendent, thinking that the shield was moving very slowly, determined, contrary to orders, to open one of the center doors so as to let the mud come in and so let the shield go ahead faster. The silt shot in under such pressure that it buried some of the men before they could escape; the rest of the shift got away through the upper emergency lock which was then 115 ft. from the shield face. The heading was lost and, the tunnel between the shield and the lock being filled solid with mud, there was no space for air pressure in which men could be put to work digging out the mud. The coal dock was crowded with shipping and, furthermore, the Lackawanna at that time was not particularly favorable to the tunnel enterprise, so it would have been almost impossible to get permission to dredge out the bed of the river in front of the shield so that a diver could go down and timber up the exterior opening to the doorway. The problem was solved as follows: Two heavy mainsails (one being an old one of the cup defender Reliance) were procured and a double canvas cover, about 60 ft. by 40 ft. made of them. Around the edges were secured small weights of pig iron. The canvas was spread on a flat barge and lines carried to fixed points to hold the mainsail in the position; the barge was withdrawn and the mainsail allowed to drop to the bed of the river, 30 ft. of it covering the shield and the remaining 30 ft. extending out beyond the face toward the middle of the river. One of the pipe valves in the lock was then opened and the mud, under the direct pressure of the river, shot into the tunnel westward of the lock for 40 ft. It came in a solid stream for eight days and nights. Finally it let up for a few minutes, began again and then stopped. A cavity had formed in the bed of the river outside the cutting edge of the shield until the canvas dropped with the cavity and was eventually drawn into the opening of the doorway through which the mud was pouring. A small cavity was excavated in the mudfilled tube ahead of the lock and the air pressure being put on, it immediately relieved much of the strain on the temporary canvas cover. Miners were then able to get into the tunnel and dig out the mud. In about nine days the heading was recovered and the door on the inside closed.

AN EMERGENCY ANTICIPATED.

The north tube is an extension of an old tunnel abandoned some years ago. Within 100 ft. from the point where the shield stopped in the previous attempt, was a reef of rock, standing from 1 to 16 ft. above the intended grade of the tunnel. Before the shield arrived at this point, it was necessary to build a temporary workshop in the river ahead of the shield, so as to build on the front of it a steel apron under which men could work in drilling the rock and blasting it out of the path of the shield. Above the rock was soft silt and, above that, from 60 to 65 ft. of water. It was expected that, in blasting the rock with so slight a cover and with such heavy water pressure, the heading would probably be blown out. Clay loaded on barges was, therefore, always held in readiness to be dumped into any such blowout. After a few weeks the expected blowout occured and the 900 ft. of tunnel from lock to heading was flooded. The men at work escaped. The clay scows were immediately brought over the blowout and dumped, thus blocking the hole. The water was pumped out into the western workings, and within 11 hours men were able to reach the heading on a small raft. No damage was found and work was soon under way again. In all, only 21 hours time were lost. There were two more blowouts while the tunnel was being built across the 700 ft. of reef, and in each case they were similarly dealt with.

MAKING BRICKS UNDER WATER.

Finally, however, there arose a problem which could not be dealt with by dropping these clay blankets. At the extreme eastern end of the reef the rock rises about 16 ft. above the bottom of the cutting edge of the shield. The tunnel at this point is so near the bottom of the river that the clay was almost fluid and continually slipped into the pockets of the shield, so that the men could not get out underneath the apron to drill the rock. Scow after scow was dumped, but the clay would not hold. Finally blow pipe flames, fed from two tanks of kerosene, were directed against the exposed clay until it was indurated,

so as to hold its position while the men drilled the rock. The blow pipe process took eight hours, during which time streams of water were continually played on the shield structure to prevent its being damaged by the high temperature. This is probably the first time that man has made brick in the bed of a river.

REINFORCED CONCRETE CAISSONS.

There was a serious problem on the New Jersey side in regard to the transverse tunnel running from the river tubes north to the Lackawanna terminal and south to the Erie and Pennsylvania terminals, and thence to the downtown tunnel of the Hudson & Manhattan. The problem was to eliminate, as far as practicable, all crossings of the tubes at grade and still give each track a connection with all the terminals mentioned. The south tube of the uptown tunnel was, accordingly, carried under the north tube at the Fifteenth street shaft, Jersey City. About 200 ft. west of this shaft a reinforced concrete caisson (known as caisson No. 1) was sunk from the surface; the caisson is a two-story structure, carrying two tracks on each level. The south tube enters on the lower level, and trains are switched in the caisson to the north or to the south. The north tube comes on the upper level, and branches similarly north and south. The caisson is 105 ft. long, 23 ft. wide at the easterly end, and 46 ft. wide at the westerly end; it is 51 ft. high, is sunk 85 ft. below tide level, and the total weight is about 10,000 tons. There is a similar caisson (No. 2) about 700 ft. west of the first one. In caisson No. 2 trains from Hoboken may be switched over to New York or to the Erie and Pennsylvania stations in Jersey City. Caisson No. 3 is south of caisson No. 2, the three caissons making a triangle. In caisson No. 3 trains from the Erie and Pennsylvania stations are switched either to Hoboken or to New York. It was originally intended to use steel caissons, but the high cost of steel and uncertainty as to the delivery of material resulted in the decision to make them reinforced concrete with steel cutting edges, being the first of their kind. They were sunk to position and the shields then run into them, making in a unique way underground switch yards, and saving a large amount in cost and in time, the latter being of the utmost importance. It would propabably have taken about nine months and cost $75,000 to make one steel caisson. All the caissons were sunk under air pressure.

GREATEST DIFFICULTIES NOT APPARENT.

Perhaps the greatest, though not the most spectacular, feat in all the construction thus far completed was the building of the tunnels at the intersection of Christopher Street, Ninth street and Sixth avenue, in Manhattan. From this point two tunnels go east under Ninth street and two north up Sixth avenue. Here there was the elevated railroad overhead, the Metropolitan Street Railway lines on the street surface, and buildings on each side of the street. It was a problem similar to the intersections in Hoboken, just described, but in this case, of course, sinking a caisson was out of the question. To accomodate the two tubes coming up from the south and the four diverging to the east and north it was necessary to build an arch whose maximum width was 68 ft. The work was all in running sand and was done under air pressure. Two iron-lined tunnels were run through this intersection first, and the side-walls then built in. Openings were then made at the tops of the tunnels and timbering for strutting was carried up so that sufficiently heavy false work could be put in for springing the arch. After the arch was completed the two temporary tunnels were taken out. This work required the greatest ingenuity and care for at least eight weeks. Any accident to the timbering, any loss of the necessary air pressure, or any carelessness of the men, would have undoubtedly caused a cave-in, and the elevated structure and the surface lines, together with the streets and the buildings on each side, would have fallen into the excavation. Every square inch of the treacherous ground had to be protected by wooden sheathing the moment it was exposed, otherwise the vibration of the passing trains above would start the sand running. This part of the work was the last of the excavation necessary for opening the railroad to traffic, and although it was early in last December when the spring of this large arch was under way, it was finished so that trains could be operated on February 10, 1908.

It is proposed that the word "kelvin" be laid before the International Standardization Commission as the kilowatt-hour unit, thus honoring the memory of the late Lord Kelvin and giving a short expression for the kilowatt-hour.

RIGHTING AN OVERTURNED CAISSON

In Chesapeake Bay, two miles off the mouth of the Magothy River, at the entrance of the main ship channel to the City of Baltimore, there now stands the completed foundation for a large lighthouse. The erection of the superstructure is merely a matter of time and involves no difficulties or unforseeable contingencies, but the story of the foundation is one which cannot fail to interest the engineer, and even the general reader, inasmuch as the progress of the work involved a serious catastrophe the consequences of which were corrected by ingenious and unusual engineering arrangements. The account which follows is abstracted from the narrative of Mr. H. P. Kieffer.

Fig. 1 is a vertical section of the foundation as completed. The lower part of the base consists of a square wooden caisson measuring 48 ft. on a side at the bottom, 46 ft. on top and 21 ft. high, having the usual working chamber and air and dredging shafts. This caisson carries a cast iron outer cylinder, 45 ft. in diameter for the lower five courses, then rising in a conical shape for four courses, and then rising for three courses with a uniform diameter of 30 ft. to a trumpet-shaped top. The total height of the cylinder is 82 ft. 3 in., and the total height of the whole foundation pier is 103 ft. 3 in.

Work on the caisson was started in the spring of 1904, but on account of various delays it was not ready for launching until the middle of summer. During the launching the caisson ran off the ways and grounded in the mud. A dredge was brought into service and the mud was dredged away from the front of the caisson. The Baltimore ice boat and a number of powerful tugs were then attached to it and succeeded in getting it afloat. Two rings of flanged cast iron plates, each ring 45 ft. in diameter and 6 ft. 3 in. high, were bolted to it and the caisson was towed to the site.

The structure had to be sunk through 55 ft. of mud, a 4-ft. stratum of coarse sand and finally into about 2 ft. of fine sand, in which it was expected to come to rest. When the caisson arrived on the site on September 19, 1904, the contractors immediately began to fill the rings with concrete. Two more rings were added, making the cast-iron cylinder 25 ft. high. The water at the site of the lighthouse was 24 ft. deep and the caisson with the two rings on top drew about 23 ft., and was floating with the cutting edge just above the mud. This mud was so soft that a pile stood on its end sank 15 ft. into it of its own weight. It was the intention of the contractors to load the rings with concrete until the weight should cause the caisson to sink

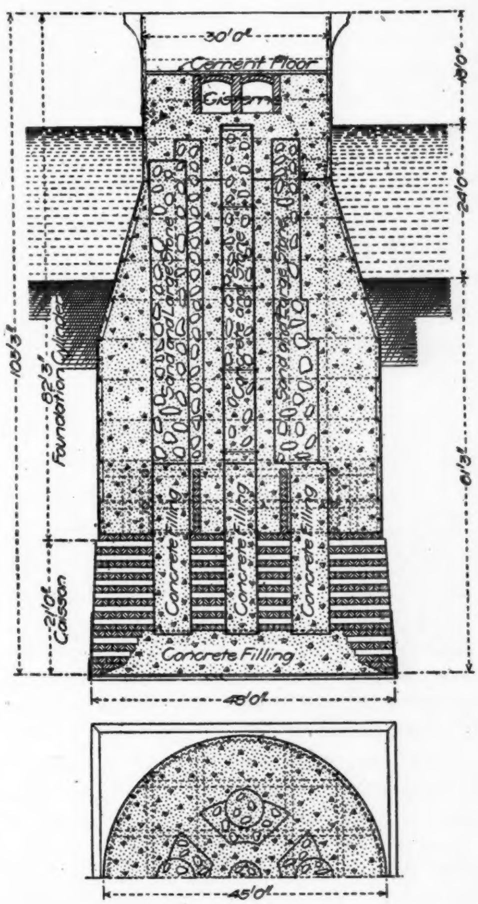


FIG. 1—VERTICAL SECTION OF FOUNDATION.

through the soft mud to the harder stratum below, after which it was intended to put on the air and sink the caisson by the ordinary pneumatic process.

For the purpose of carrying on the work the contractors provided three barges about 200 ft. long, one of which was an old bark with all three masts in place and the others were old ferry boats. These barges provided quarters for a crew of about 150 men, and

one of them was fitted with three boilers, two air compressors and other appliances necessary.

Owing to bad workmanship, the deck of the caisson leaked to the extent of about a two inch stream, and as the specifications required that the concrete should be laid in the dry, the leak and necessity of working in dry sections caused more delay. Finally concreting was started, and a layer about one foot thick was placed over the whole deck. The space inside the two lower rings was divided into three parts by two water-tight bulkheads 12 ft. high, running about north and south, after the caisson was anchored in position. Concrete was placed alternately in each of the outside pockets.

When the concrete in the east pocket was 4 ft. 9 in. above the deck, that in the west pocket was 2 ft. or more below, and the whole structure took a list to the east, and more concrete was rapidly thrown into the west pocket, until it reached the height of 13 ft., when the top of the structure began to move to the west.

This point was reached on the morning of October 12, when a gale came on from the northeast, in which direction the site is exposed to the whole sweep of Chesapeake Bay, and before night the caisson lay with one side 46 ft. below the surface of the bay, and the other just awash, while the contractors' boats were blown ashore, and lay among the breakers, two miles to leeward. Fig. 2 shows successive positions of the caisson.

The next day the contractors made an assignment. They claimed to have expended up to this time about $70,000, much of which, however, was for plant and equipment. The loss of the caisson was caused wholly by bad judgment, and entire lack of the most ordinary precautions. If, instead of mooring the caisson with a few anchors and attaching to it the three large and clumsy barges, all of which, including the caisson, bobbed and wabbled around with the waves, a half dozen dolphins of heavy piles had been driven, and the caisson and barges had been properly moored to these, it is probable that the whole equipment would have ridden out the gale of October 12, although the overloading of one side of a structure whose center of gravity was necessarily high, was a fatal error.

The winter and spring of 1905 was wasted in discussions between the receiver and the creditors over ways and means to raise the caisson and complete the work. Contractors, engineers, wreckers and experts of all kinds were brought in, all to no purpose; and finally in June 1905, the Goverment declared the contract in default, and called on the United States Fidelity & Guaranty Company, surety on the contractor's bond, to complete the work.

In August 1905, a subcontract was entered into between the surety company and a New York contractor, who after working the rest of the season, and taking off some of the iron plates, but accomplishing nothing of real value, was ordered off the work by the Goverment, and in the spring of 1906 the work was taken up by the surety company, under the plans

After a careful study of the problem, it was decided that the best way to right the overturned structure was to construct a tower and direction of Mr. Chas. F. Wood.
or derrick on the caisson, and suspend thereon enough lead to shift the center of gravity to a point near the toe or cutting edge of the caisson, and then apply sufficient force through hoisting engines and derricks to revolve the structure through a quarter turn.

In order to insure stable working conditions, and eliminate the chance of disaster at a critical moment, a wharf, Fig. 3, was con-

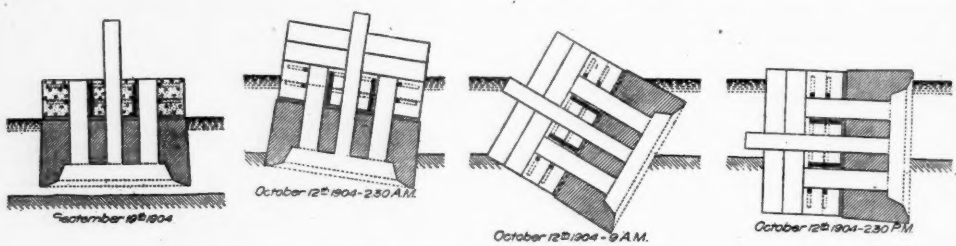


FIG. II.—SUCCESSIVE POSITIONS OF OVERTURNING CAISSON.

structed around three sides of the caisson, 75 to 80-ft. piles being used in this structure. On this wharf were installed the boilers, engines, compressors and other plant, and equipment, including two 25-ton derricks, and the houses for the protection of the machinery and men. To secure fresh water for the boilers and other purposes, a 6 in. artesian well was driven into the bottom of the bay, about 184 feet below high water, at which depth a stream was tapped under a head of about 6 ft., which overflowed the pipe into the bay, like a fountain. This well furnished practically all the water used on the work, and at the time of greatest activity supplies nearly 30,000 gallons per day. The water from the well being somewhat impregnated with sulphate of iron, during the latter stages of the work, a homemade iron pipe condenser was used to supply water for drinking and cooking purposes. The value of the well can be gathered from an experience in bringing down one scow load of water, which cost $2.50 at Baltimore, but which for towing and other charges represented a cost of $69 when delivered on the work, and was used in one day.

A very interesting feature of the well driving operation was the bringing up, from about 160 ft. below the surface, the water washed sand and gravel of an old beach. Along with the sand and other debris, came many pieces of wood, worn smooth by the action of waves, and showing the borings and remains of sea insects. The color and texture of this wood was almost that of ebony, but the grain of the wood was that of pine and it cut with a knife almost like charcoal. Evidently it was the remains of a past geological era, when the beach of the Atlantic was near the western shore of Chesapeake Bay, and before there was such land as the peninsula of Delaware, eastern Maryland and Virginia.

The first operation on the caisson was to replace with divers some of the plates removed by the sub-contractor above referred to, the second and third rings, which had been partially taken off, being re-completed. The tower was built on the side of the caisson seven lengths of 2-in. plow steel cable was drawn under and around the rings and both ends of each carried over the top of the tower and to the end of the boom. One hundred and twenty tons of pig lead was bunched into ten weights of twelve tons. "I" beams were slipped through three of the dredging shafts, and by means of saddles given a bearing on the upper side at the deck of the caisson, and on the lower side at the roof of the working chamber. One 12-ton weight was hung on the center spud, and one of the large derricks above referred to was attached to each of the side spuds. Four-part lines reeved through double blocks were carried to the front, rear, and side from the top of the

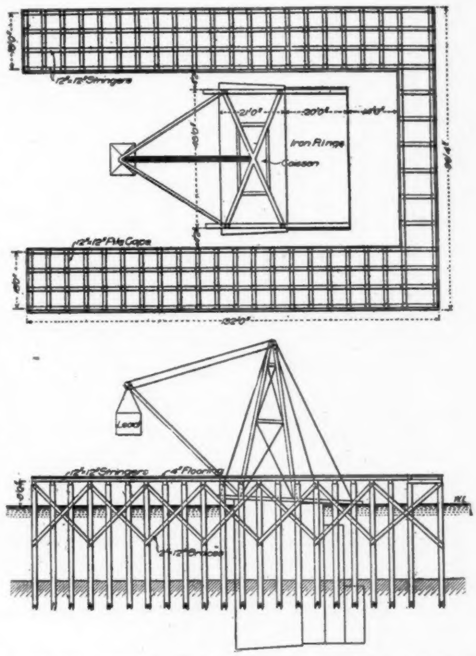


FIG. III.– OVERTURNED CAISSON WITH WHARF BUILT AROUND IT.

tower on each side and the leads taken to the six drums of three double drum engines. A trench was pumped in the mud all around the caisson down to the lower edge, and the mud was partially removed from in front of the caisson.

In addition to the force applied directly to the caisson itself through the spuds above described, extra precautions to prevent the iron rings and concrete pulling away from the woodwork at the lower side, by reason of an unequal pull on the iron and wood, was taken by tying the rings and caisson together with $1\frac{1}{4}$-in. cable and turn-buckles. Hooks were made to go over the upper flanges of the third course of plates and over the cutting

edge of the caisson. Forty of each were used, and the pairs fixed together with cable, drawn up with turnbuckles, as above, so as to tie the iron and timber into one mass, and insure the turning the structure as a whole. Most of these ties were placed and made up by divers.

Nearly two months were lost waiting for two large derricks, which were bought for May delivery, but finally everything was declared to be ready and the first effort to move the caisson was set for the next day.

tons of cable, caused the structure to move forward about 1/16 in. per hour. Late that evening the balance of the lead was hung. A test was made with the hoisting engine, and the mass moved forward about 3 ft. Then to prevent the forward movement, which kept on at the rate of more than 1 in. per hour, the lines to the rear from the top of the tower were tightened and everything held in place, until the arrival of the invited guests at noon the next day.

On Saturday, September 30, the president

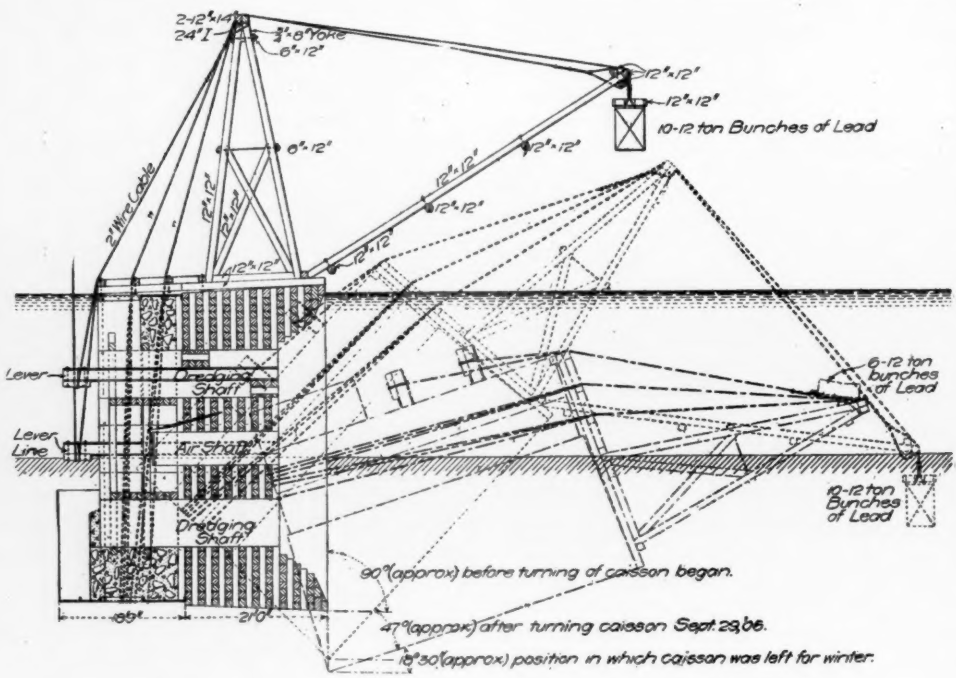


FIG. IV.—SUCCESSIVE POSITIONS OF CAISSON AND TOWER IN RIGHTING.

In estimating the weight, displacement, leverages, and other factors, it was calculated that 100 tons of lead, acting with a lever arm of 58 ft. would bring the mass in equilibrium on the axis of the center of gravity of the wooden caisson. The additional 20 tons was added to insure that the neutral axis should be between the center of gravity, about 7 ft. from the deck, as planned by the United States Lighthouse engineers, and the cutting edge of the caisson.

On Friday, September 29, when 95 tons of lead had been hung in place, that weight, aided by about 3 tons weight of boom and 2

of the company, the lighthouse officials and guests arrived. At 1 P. M. the stops were cast off the lines, the word given, and the structure turned through about 47 deg. in about as many seconds. Everything worked out just as planned and before night the divers were down hooking on to the lead weights, which had brought up on hard bottom. During the next few days, one by one, the 12-ton bunches were lifted, and laid on top of the tower. The cables to which the lead was attached were pulled aside; the boom released and floated out of the way, large centrifugal pumps, with jets attached to the suction pipes

were started, and the mud under the high side removed allowing the caisson to settle slowly into the bottom.

Cold weather interrupted the work about December 1. All the machinery was removed from the wharf because of the possibility that the ice, which in this particular part of the bay is very troublesome, might carry it away. The wharf stood, however, and except for the breaking off of a few piles, everything was found intact when work was resumed in the spring of 1907.

Early in April, the machinery was again installed on the wharf. One of the barges was kept afloat and became one of the most useful helps on the work. The old hulk was never laid off the job, being moved round and round the wharf to find a lee when storms blew, all of which it outrode gallantly, and there was not a point on the wharf where her 70-ft. boom could not be brought to bear to lift and perform whatever work the fixed derricks were not able to reach. The two large derricks previously mentioned were replaced by a tower, and the two 12 x 12-in. booms with three and four-part lines for lighter and more rapid work.

The tower was removed from the side of the caisson; the 2-in. cables were withdrawn from around the rings; the spuds were taken out of the dredging shafts; pumping was resumed, and the plates of the fourth, fifth, sixth, and seventh courses of iron rings were put in place, most of them under water, with the aid of divers. This brought the structure above water. A 1¼-yd. cube concrete mixer was installed, and ten 20-in. 65-lb. 60-ft. I beams were thrown across from the two sides of the dock, and floored to secure additional space. A cement house and other structures were built. Temporary wooden doors were fitted at the bottom of each of the four dredging shafts and concrete to the depth of about

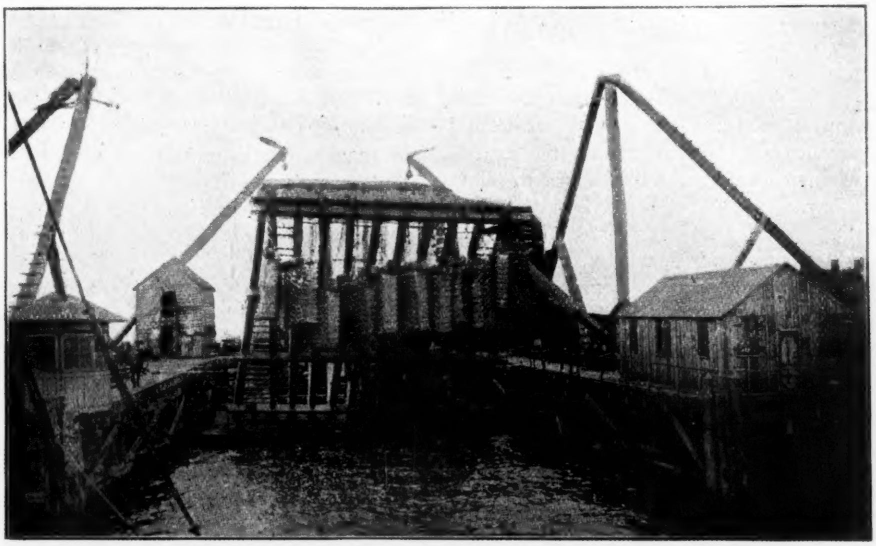


FIG. V.—LEAD WEIGHTS HUNG ON TOWER OR DERRICK OF CAISSON.

6 ft. was deposited in each by means of a bottom dump bucket. While this concrete was settling additional sections of the air shaft were added to bring it above water, and preparations were made to pump out the cylinder.

In turning the structures, the cutting edge of the caisson, which at the start was about 46 ft. below the surface, sank about 11 ft., the movement being forward and down at the same time, so that the deck of the caisson was about 36 ft. below the surface of the bay, when the time came to empty the cylinder of water. The displacement of the cylinder was about 50 tons per foot of depth, and weight to the extent of about 1800 tons had to be provided to prevent the structure from jumping out of the water like a big cork. This was provided by rubble boulders weighing from ½ to 4 tons each, which were lowered

into place by derricks and placed by a diver. Several scowloads of sand also were thrown into the cylinder. Old sails were wrapped around the outside of the cylinder, wound with many turns of hemp line, hove taut with an engine, and the pumps were started to clear it of water.

At this point came one of the most troublesome and expensive difficulties of the whole operation. It had not been considered that emptying the cylinder presented a serious problem, but on trial with a 10 x 8-in. Lawrence centerfugal pump with an 8 x 8-in. engine, it was found that while the water could be lowered about 3 ft. in about 11 minutes, it returned at the rate of 300 cu. ft. per minute, and in 15 to 16 minutes from the time the pump stopped the water level inside and out was the same. Experiment after experiment was tried but it was like trying to pump out the bay.

Finally a new canvas, 37 x 150 ft., made of No. 4 duck was secured, cut to fit the batter of the sixth course, and well roped around the edge. This was drawn around the cylinder and tightened up with an engine. Strips of 1 x 6-in. wood were put along the vertical joint inside and outside, and the two strips nailed together every 6 in. by a diver. This reduced the leakage more than half, but the flow was too strong to permit laying concrete. Then about 4,000 cu. yd. of mud were brought from one of the dredges working in Baltimore harbor and dumped in the slip between the points of the wharf, after which a ¾-yd. clam-shell bucket was used to bank the mud around the cylinder. By this means the leakage was reduced to insignificant proportions, and thereafter was handled conveniently by a No. 3 Emerson pump, running an occasional stroke. Practically all this trouble, delay and expense was caused by the removal of the plates, which was the only thing done by the sub-contractor who attempted the job after the failure of the original contractor.

Each of the 45-ft. diameter ringes was made up of thirty cast iron plates about 5 ft. x 6 ft. 3.-in. x 2-in. thick. These plates had 8-in. flanges all around and were bolted together by 2-in. bolts.

After the leakage was surmounted, the cylinder was quickly filled with concrete up to the middle of the sixth course, the large stone being moved from side to side until it was placed on the concrete. At no time was the weight allowed to drop below a safe load required to hold down the empty shell.

The pump was continued in service for nearly three weeks, almost without a stop and with practically no attention, until the concrete was brought above the surface of the bay, a sump being left all the way around the deck of the caisson. Iron pipe channels were left at various points leading to this sump. After the pump was removed, the sump was closed except for a 2-in. pipe connection to which a grouting machine was attached, and the sump and all of its channels pumped full of grout under an air pressure of 140 lb. The cubic contents of the sump and its connections were very carefully calculated, and a sufficient amount of grout was forced in to entirely fill the space. Thereafter the surface of the concrete was never allowed to get below water level. During the period when concreting was going on, the air compressor plant was thoroughly gone over, an electric light plant was installed and men and material locks were secured. A hospital lock was fitted up and a physician experienced in the care of men working under compressed air placed in charge as medical director.

The class of labor was rapidly changed. Sand hogs were brought from New York under experienced foremen. The locks were placed, air turned on and the sinking commenced and continued without interruption until the end.

Some of the clay stratum on which the caisson rested when the air was turned on, was taken out with shovels and a bucket, but most of the material was blown through a 5-in. iron pipe carried up in the air shaft and turned overboard. At its end it was fitted with a short length of 4-in. suction hose, and a 4-in. plug cock served to close it when necessary. The material was washed to a sump by one or more jets from a 2½-in. fire hose nozzle supplied with water by a pump on the dock.

The men worked in two shifts, varying from four hours each at the beginning to one hour each at the end. The air pressure varied from 25 to 40 lb.

One of the serious troubles the men had to contend with at the start of the air work was sinking through an old oyster bed or bar at a depth of about 60 ft., which evidently had

once been the bottom of the bay. The oyster shells, which were very numerous, clogged the blow pipes, cut through rubber boots, gloves and skin, making the progress slow, difficult and painful.

SMALL PIPES FOR AIR LOCK.

The material lock was fitted with large connections and valves, so that materials could be locked in and out rapidly, but the man lock, which was on the side and entirely separate from the other one, was fitted only with a ¾-in. valve, and so rapid ingress and egress was impossible. It is common practice on similar work to use as large a valve as 2-in. This condition caused considerable complaint on the part of the men at first, but they were soon accustomed to waiting patiently for decompression.

During the long delay between the closing of the caisson and the putting on of the air, the teredo had been very busy in some of the exposed parts of the caisson. It was necessary to remove some of the bulkhead timbers within the rings entirely, but most of those in the working chamber stood up to the work, the holes being afterward pumped full of grout with the grouting machine. The caisson itself was strained slightly by the turning, and a few of the caulked joints in the working chamber opened slightly.

No special difficulty was experienced in mudding up these leaks, although they required constant attention, and, together with the worm holes, caused a considerable blowout of air on the southeast corner. This leak was not regarded entirely as an objection, as it served to keep the air in the working chamber in good condition, and taken as a means of ventilation not requiring more air than would have been otherwise wasted, no strenuous effort was made to close it. In addition, the porous sand stratum below the blanket of mud at the bottom of the bay absorbed a large volume of air, and in calm weather the bubbles of air could be seen rising in all directions for a long distance from the work.

After the concrete was started the work never stopped night nor day until the working chamber was filled with concrete, sealed and the air taken off. During 1906, and until August, 1907, the work was carried on with a small force working only one shift. The main volume of concrete was placed by three shifts working throughout the 24 hours, and for considerable periods, the material handled averaged a cubic yard in each six minutes. After the concrete reached the surface of the water, one shift easily placed the material as fast as the caisson sank.

In filling the working chamber all but the last few yards of concrete at the bottom of the central air shaft was dropped through two 12-in. diameter iron pipe shafts leading through the north and the south dredging shafts. These pipes were installed when the temporary doors were put in the shafts, and built in the concrete as it came up. A 12-in. Jenkins straightway back-pressure valve was placed at the top of each to hold the pressure and act as a lock. A wooden target with a rubber gasket was used at the bottom of the pipe to hold the air, when the top valve was opened to fill the pipe with concrete from the hopper platform. Means were provided to equalize the pressure with the main air shaft, and the arrangement worked reasonably well. Some trouble was experienced from stoppages due to the long length and small diameter of the pipe. It proved that for tubes for this purpose. particularly if as long as these, 84 ft., the diameter should be not less than 16 in., and 18 or 20 in. would probably give better results.

Outside of the small boiler on the barge, four boilers were used; two of them were of the marine type of 125 h.-p. each and the other two were verticals, aggregating about 100 h.-p. Two Class A straight line Ingersoll-Rand compressors were used, one high-pressure machine of 1,250 cu. ft. per minute, and the other a low-pressure machine of about 900 cu. ft. free air per minute. Air receivers and an air cooler made up of 6-in. pipe carried through a tank of water under the pier were provided, and the conditions in the caisson so far as the air was concerned were at all times pleasant and agreeable.

A 12½-kw. generator and engine was installed. The lights for all the houses and around the outdoor machinery, and also those in the locks, shafts and caisson, as well as the arc lamps for general illumination, were attached to this machine.

The number of men employed during the last few weeks average 115. There was no special sickness and only two or three men were sent away from the wharf on that account. No one was seriously injured and there were but two slight casualties during the

progress of the work. The reasons for this happy condition Mr. Wood attributes to the care exercised in picking out and looking after the men, to the short shifts, which aided in keeping up their vitality, and to the entire lack of means for dissipation on the part of all employed. The rest and food were factors, as was also the care taken in securing a pure air supply; the ventilating and lighting of the air chamber also aided. *The provision of only small openings on the man lock,* which made it absolutely impossible for any of the men to do otherwise than observe the rules of the best practice for compression and decompression in entering and leaving the caisson was undoubtedly of value.

Taking into account the number and character of the men employed, the length of time for which they are engaged, the hazardous nature of the work, the remote location and narrow limits within which a large number of men labored and were housed, fed and cared for, the operation is remarkable, and in this phase of it Mr. Wood takes a great deal of pride. He also specifies by name a considerable number holding responsible positions who co-operated with him, and in conclusion aknowledges also his great indebtedness to the men who, through long nights and days of strain, stress and struggle, in intense heat and bitter cold, in calm weather and with gales blowing, often at the risk of life and limb, performed their part. As he expresses it: "No matter what his ability, no man gets very far or does very much except through the loyalty and co-operation of those on whom he depends to execute his ideas. Therefore after everyone else has been given full credit, what is left you may award to me."

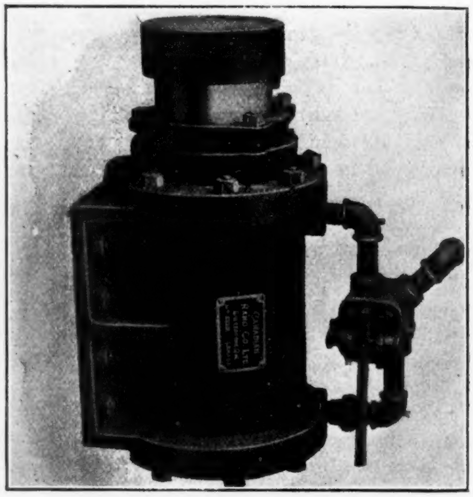
A WATER CARRYING DEVICE

A sugar refinery at Crocket, California, is so situated that while it has the ocean to draw from there is no supply of fresh water, which it of course requires in considerable quantity. It has had built for it a large barge, and this barge is towed up the river where the water is fresh and then allowed to fill until it is submerged almost to the deck. It thus brings to the refinery to be pumped out about half a million gallons per trip.

If this barge had an air tight deck and hatches to fasten down what a simple thing it would be to lead a compressed air hose to form a pressure on top of the water and then have another hose by which the water could be delivered to storage tanks anywhere about the plant as required.

A SPECIAL PNEUMATIC RAM

We show here a special pneumatic ram built by the Canadian Rand Company, for the Dominion Car & Foundry Company, Montreal.



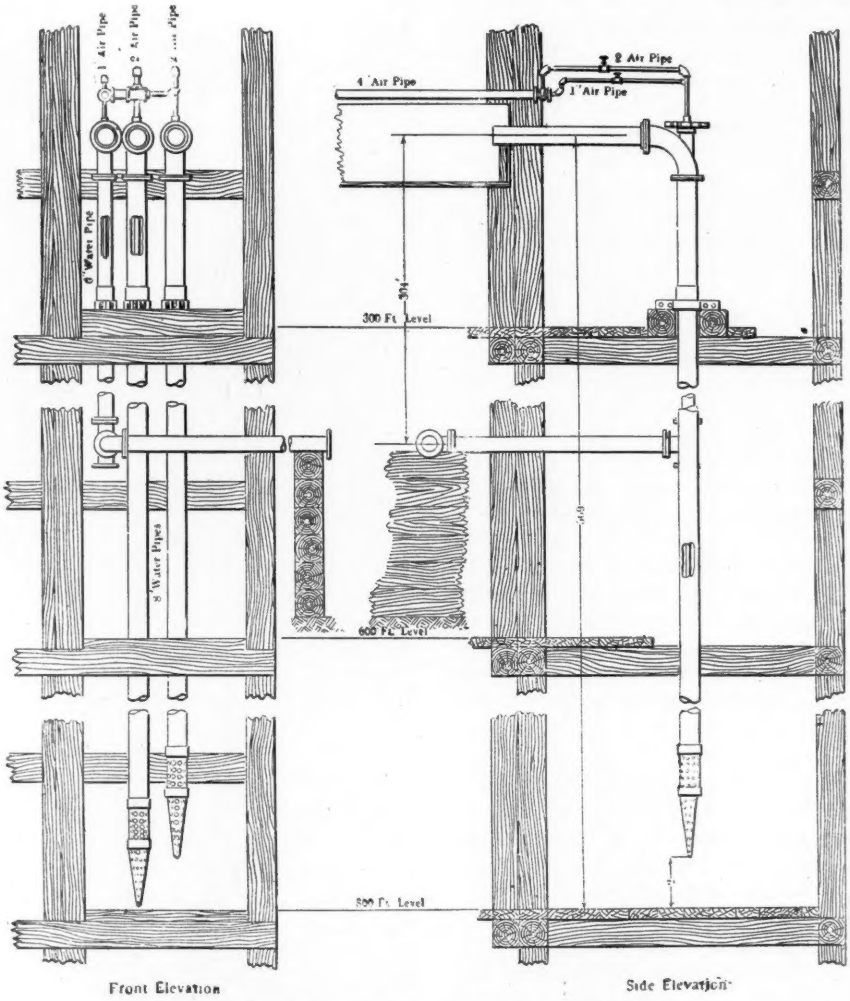
A SPECIAL PNEUMATIC RAM

It is used for pressing brake heads on the brake beams. The cylinder is 10 inches diameter allowing the plunger a travel of 10 inches, and the usual shop air pressure of 80 lbs. is employed. The press or ram is mounted on a steel frame with a post at the opposite end, the space between the post and the ram being just sufficient to take in the brake beam. One operator controls all the operations of the ram by the single lever shown, while another puts on the brake heads, first the one next the post and then the one next to the ram. The valve is dust proof and air balanced, with four ports admitting the air to or discharging it from either end of the cylinder. Instead of drawing in air from the shop, admitting with it dust and dirt, the air is taken only from the receiver for the forward stroke and for the backward stroke the same air is exhausted from one end to the other, thus preventing dust from entering the cylinder.

THE AIR LIFT IN UNWATERING THE HOMESTAKE MINE

The episode of the fire which occured last year in the Homestake mine at Lead, South Dakota, has been narrated in graphic detail by Mr. Bruce C. Yates, assistant chief engineer of the Homestake Mining Company, in the *Engineering News*. The mine was of large extent and contained an immense quantity of timber distributed through a labyrinth of stopes at different levels. The entire stope area in feet was a mass of loose rock and timber with also numerous bulkheads built years ago to support pillars of ore while adjacent stopes were being worked. The fire began on March 25, 1907 and was from the first beyond control. After exhausting all expedients the mine was flooded, and then came the unwatering in order to resume mining operations. This was done mostly by bailing with skips in the several shafts lifting 1,000 gallons at a time, some of them 2,000 gallons.

A system of air lifts was installed at the Ellison shaft, which proved to be of great assistance. Two 8-in. pipes were lowered from the 300-ft. level to the 800-ft. level in the pipe compartment, and a 2-in. pipe was put inside of each 8-in. pipe extending down 240 ft. below the discharge. The 8-in. pipes had a conical end at the bottom, provided with 2-in.



AIR LIFT FOR UNWATERING HOMESTAKE MINE.

holes in the surface of the cone. The area of these holes is about 2½ times the area of the pipe cross sections. On the lower end of the 2-in. pipe were pieces of pipe about eight inches long with numerous small holes in the circumference, pointing upward at an angle of 45 deg., the ends of the pipe being closed with a cap. The discharge ends of the water columns were provided with special curved elbows, having flanged openings through which the air pipes entered. Fig. 4., shows the arrangement of piping for these air lifts.

A 6-in. pipe, which is a part of the mine-fire service and which connects a tank on the 200-ft. level with one on the 600-ft., was taken apart at the 300-ft. level and a 1-in. air pipe was lowered inside. This pipe threw considerable water until the water was lowered 200 ft., although there was one tee and one elbow at the lower end. Both 8-in. water columns were made of screw-connected pipe, put together a length at a time, and lowered by block and winch. Air at 80-lb. pressure was first used, but when the air pipes were lowered, air at a pressure of 85 lb. was turned into one of the columns.

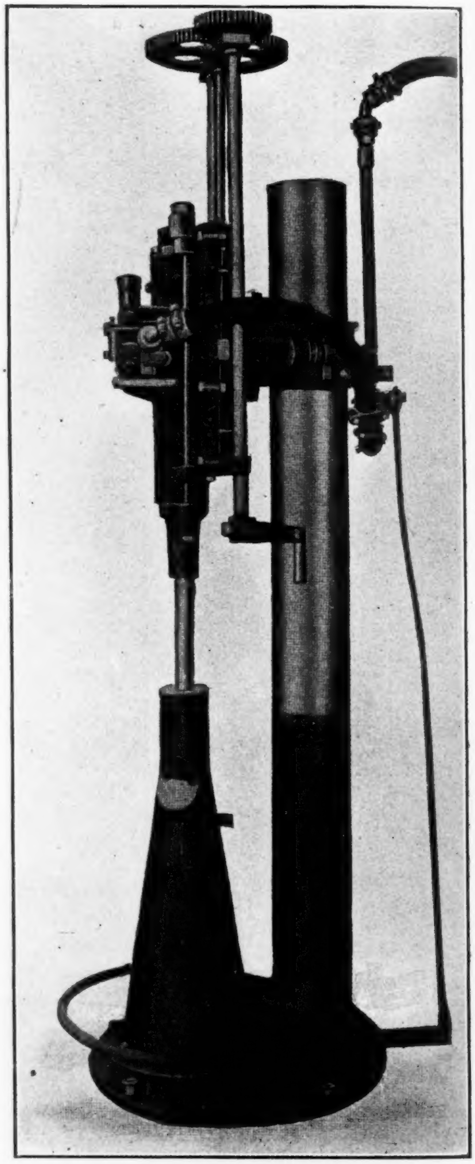
When the air-lifts were discontinued the high-pressure line was lifting water 336 ft. with a submergence of 171 ft., and the low-pressure line was working against the same head with a submergence of 135 ft.; the two together were raising about 600 gal. per min. When the three pipes were at their best efficiency they raised 4,397,000 gal. in 24 hours, with the water level standing 87 ft. below the discharge and submergence of the air lines of 157 ft.

The total amount of water pumped from the mine by the air lifts was 83,469,000 gal. The average per day, during 31 days, was 2,692,550 gal. The total amount hoisted and pumped from the mine during the time was 309,891,500 gal., of which the air lifts raised 26.9 per cent. The best record for 24 hours made by all of the skips was 8,724,000 gal., and the Ellison shaft alone hoisted 4,500,000 gal. in 24 hours from about 185 ft. below the 300-ft. level.

A NEW PNEUMATIC FORGING HAMMER

The half tone shows a handy pneumatic hammer for blacksmiths, built by the Canadian Rand Drill Company. The following notes regarding it are by Mr. T. Chabot, of the Sherbrooke shops of the company.

We find the new hammer better than the belt driven style in that it is more easily controlled and its range of work is practically unlimited. We use it on all kinds of comparatively light work, i. e., sizes ¼ in. to 2 in., round or square. It is used to great advantage



A HANDY PNEUMATIC HAMMER.

on welding springs and drawing out ½ in. to 1¼ in. sizes.

It is arranged so that the valve is operated by a treadle, leaving both the operator's hands free to attend to his work. The principal advantages of the hammer are that the operator can control the blows so very easily, and this with the foot, leaving him free to use chisels, formers, etc., under the hammer, without a helper; the facility of adjusting the hammer to the work in hand, which is done with a few turns of the feed handle; the ability to change the stroke from 8 in. to 1 in. or vice versa, without interrupting the work.

Some of the jobs we keep it busy with are: Drawing out springs, cold chisels, picks, bars, lathe tools, etc., and welding and drawing out stock to 1¼ in. Not least worthy of mention is the space occupied, the hammer being set on a concrete base only 30 in. in diameter.

We are preparing to use it in upsetting and forging bolts in a bolt vise. This will be done by putting a safety clamp under the column clamp, which will permit the hammer to be swung around over the vise for upsetting and back again over the anvil to forge the head to hexagon or square.

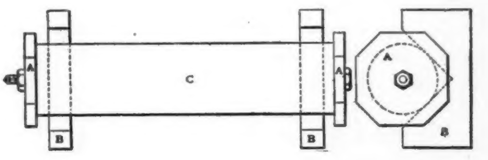
EARNINGS OF A DRAINAGE TUNNEL

Mr. T. R. Countryman, engineer of the new Cripple Creek drainage tunnel, in a paper before the Colorado Polytechnic Society, gives some interesting matter concerning the value of the El Paso tunnel completed in 1903. He says:

"Assuming the average cost of lifting 1,000,000 gallons 600 feet in the Cripple Creek district to be $125, then the El Paso tunnel has earned to date fully $1,000,000, and it is still at work. It works every minute of the day and every day of the year. There is no expense connected with it, and no flooding of levels on account of labor strikes or accidents to machinery. This tunnel has lowered the general water level of the district, as shown by the subsidence of the water at the Elkton shaft, a total of 160 feet. Perhaps the average reduction would not be so much."

It is stated in the paper referred to that the new Gutch Park or Roosevelt tunnel, now in progress, will cost 20 per cent. more than first estimated, but:

"Even should it cost 100 per cent. more the mine owners cannot afford to abandon it, for it will in the end save many times its cost in pumping alone. It will also save very largely in other mining costs, particularly labor. The completion of the tunnel will mark the beginning of another era of activity and prosperity for the Cripple Creek district."



CHEAP AIR HOIST CYLINDERS

A contributor in a recent issue of the *American Machinist* says that he once received an order to build a number of air hoists to be used in a large railroad shop, taking for the purpose such material as he could pick up around the shop. He found some pieces of 8, 10 and 12 inch pipe and cut them into 6 foot lengths. He cut two hardwood blocks, *A*, 12 inches square and 1½ inch thick, bored a 1 inch hole in the middle of each, filled a pipe about half full of scrap and sand, bolted the blocks, *A*, to the ends by a bolt through the middle and then laid the pipe in the two cradles, *B*, as shown. The pipe was then driven by a belt around the pipe and over the line shaft for about 10 hours, and the inside was scoured out true and smooth enough for use. The hoists using these cylinders are said to have given good service and the cup-leather piston packings lasted a long time. We might suggest that if an inch or so had been cut off of each end of the pipes after the tumbling process it might have been an improvement, as the scouring could not have been fully effective in the corners.

The Cape to Cairo Railroad in Africa only requires the completion of 700 miles to enable travelers to make a connected journey by rail, lake and river from Cairo to Cape Town.

THE SAND-BLAST MACHINE "AN ELECTRICAL GENERATOR."

By B. O'Reilly.

We have had a sand-blasting apparatus in operation for some time, in the form of two cylinders made of sheet steel. These cylinders are arranged vertically, the larger one being uppermost. The lower one forms both a column to support the whole machine and a chamber to contain fine, sharp sand. The two chambers are connected by a length of rubber hose about 1½ inches internal diameter. At the end of the hose which is inside the upper chamber there is a nozzle of cast iron, the bore being about ¼ inch.

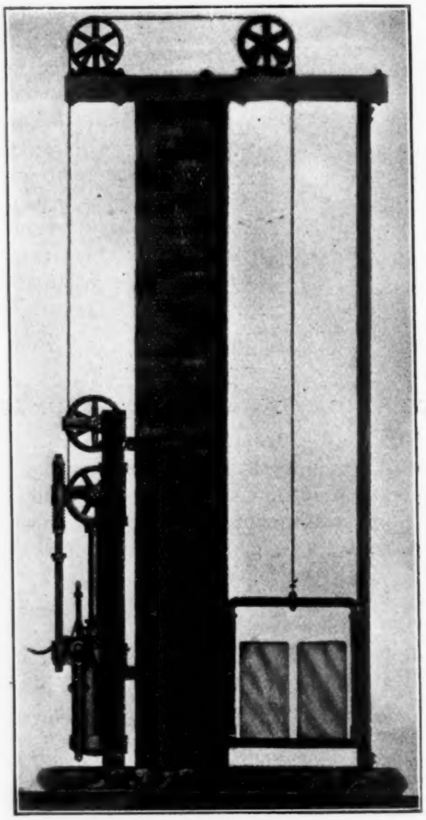
The machine is worked by compressed air, of an average pressure of 5 pounds. The compressed air forces up the fine sand from the lower chamber, through the rubber hose and nozzle into the upper one. When operating the machine, the hands are inserted through two openings in the upper chamber. One hand holds the tool which is to be cleaned, while the other, holding the nozzle, directs the current of air and sand in the required direction. The operator observes the progress of the work through a small window on a level with his eye.

A man who was using the machine complained that he had received, or imagined he had received, a curious kind of blow or shock to his arms—nothing serious, but sufficient to make him note the fact. A day or two after a pipe fitter, who had some alterations to make, laid his hand on the rubber hose. He received a shock which startled him. Another man who was near, grasped the hose, when he at once received an undoubted shock. I distinctly saw the spark and heard the sharp crack which accompanies a discharge of static electricity. As a further proof that the hose was electrified, I took a long thread from a piece of cotton waste; this was attracted by the hose, as were also other light substances.

A water-gage glass tube was slipped upon a round steel rod so that about 12 inches of the steel rod stood out at each end of the gage glass. Holding the gage glass in the left hand, the steel bar was fairly well insulated, while one end was sand blasted; so long as the jet continued to play upon this end, sparks could be drawn from the other. The use of dry hot sand gave the best results.—*American Machinist.*

PNEUMATIC ICE HOISTS

In a modern plant producing ice artificially an ice storage house is an important feature, especially in the interest of profitable operation. It enables a plant of smaller capacity to produce the year's supply by running continuously, under the most economical conditions and at its best rate of production for



PNEUMATIC ICE HOIST.

nine or ten months of the year with a shut down in the winter for general overhauling and rejuvenation. With a peak demand for 100 tons per day in August a 50 ton plant may be quite sufficient and better than a larger one for the year's total output.

We illustrate in Fig. 1, an ice elevating and

lowering machine especially designed for this service. As all ice plants have a constant supply of compressed air the apparatus is economical, to instal, to maintain and to operate. No explanation is necessary as to the design of the device. By a simple adjusting screw placed convenient to the operator the level at which the cage stops may be raised or lowered according to the height of the ice in the house. The elevator of course is used as well for taking ice out as for putting it into the house.

Fig. 2 shows a double horizontal hoist allowing two cages to be operated at the same time. These are normally for hoisting or lowering ice between fixed levels, as for icing cars or for raising ice to a loading platform from which it passes down inclines to different parts of the plant. The hoisting cylinders are not necessarily placed in the positions shown but may be located anywhere from which the rope may be strung over suitably located sheaves to the cage. Plants have been installed with as many as six cages in different parts of the building all operated by one hoist. These hoists are built by the Curtis & Co. Manufacturing Co., St. Louis.

AVOIDABLE COLLIERY ACCIDENTS

The Colliery Guardian, of London, speaks in severe terms of recent coal mine accidents in the United States. The authenticated reports of these, it says, make very interesting reading from many points of view, not the least important of which is the fact that the majority of these accidents form object lessons as useful for practical purposes as if they had been performed for the sake of experiment. Sad as has been the loss of life in connection with them, sadder still is the story which they unfold of the conditions prevailing in many of the pits of the United States, which are worked, in too many instances, under circumstances which positively court disaster.

Let us, for example, take the Monongah explosion, the precise origin of which still remains obscure, although there seems to be an agreement as to many of the facts of the case. The mines were stated to be well planned and fairly well ventilated, but were dry and dusty. Gas was present, but not in large quantities, and naked lights were used. Coal-cutting machines were largely used,

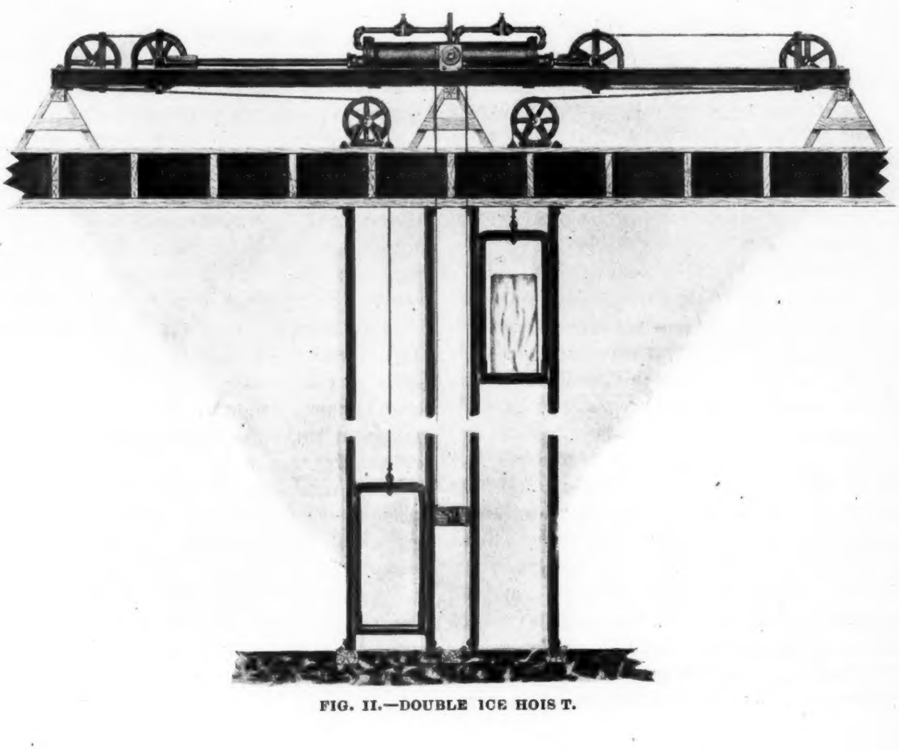


FIG. II.—DOUBLE ICE HOIST.

each machine in making one cut producing about one car-load of dust. Miners were supposed not to fire shots until twenty minutes after a cut had been made, but the shot-firing was often carelessly done, and black powder was used, sometimes in the coal itself. Naked wires carrying an electric current of 280 volts were present in the workings. Some sprinkling was done occasionally in the main entries, but little or no attempt was made to remove dust from the mine.

It would be difficult to find a combination of circumstances more favorable for the production of an explosion. It is a question whether it is worth while even to speculate upon its immediate cause. A somewhat strong body of opinion exists that it was the result of a runaway trip of wagons, and it may be worth while recording the fact that runaway trips had on two previous occasions raised such clouds of coaldust that ignition ensued and fires were caused. Something very similar took place last autumn in a pit worked by the Union Pacific Coal Company, at Rock Springs, Wyoming. Here six cars broke away down an incline of 1 in 5, crashed into a trip of full cars, and raised a dust cloud which was immediately ignited by the miners' lights, burning the men more or less, but fortunately without any violent explosion taking place. Whether such dust explosions are violent or not must necessarily depend upon the relative proportions of dust and air. In the case of the Monongah disaster, however, there is an equally strong opinion that this was an ordinary case of a blown-out shot igniting dust, perhaps in the presence of a little gas.

But, as we have said above, what matters the immediate cause when there were so many elements of danger in this pit. The inspectors who report upon this accident refer in detail to many of these, such as the excessive dust made by chain coal-cutters, the powerful charge of explosive required to break down the coal, the large amount of electric current used in the pits, the careless methods of shot-firing employed They also criticise the methods of working the pits. The seams are thick, and are worked in single cuts instead of in two benches. As many as eight parallel main headings were driven in the seams, forming special storage chambers for mine dust, and the fact that two separate mines were connected together underground is held responsible, as at Courrières, for large addition to the number of the dead. The Yolande explosion, in which fifty-six men perished, repeats a similar tale. There was gas in the pit; this gas was ignited by an open lamp; coaldust enabled the flame to be conveyed through the workings. After the disaster the company adopted a set of rules and regulations which the inspectors state are the same they have for the past five years been urging the managers to adopt.

WIRELESS ELECTRIC POWER TRANSMISSION

The Paris *Figaro* has published information of an affair which has already laid contribution on financial circles in Paris, and has, perhaps, also occupied foreign capitalists. It appears that the matter at issue was an alleged invention of a Lyons workman, who claimed to have discovered how to transmit electric power by a wireless system. As it was to be possible by means of this discovery to drive machines at any distance, it will be understood that the invention promised to create a revolution in technical work. In fact, credulous persons were found who provided money for the establishment of an experimental station, and who endeavored to gain over large capitalists in favor of the scheme. According to the inventor, a villa near Marseilles was converted into a power station, and invitations were issued for the attendance of a number of bankers and engineers to witness the proposed experiments. Everything was kept as secret as possible in order to assure the utilisation of the invention solely by the participants. The world was to be surprised, the Paris paper declares, but in a different way from that which was predicted. One of the engineers present made an examination, and it turned out that the table from which the inventor wished to transmit power into the world had by means of concealed conductors been brought into connection with the electric lighting mains of Marseilles. The power which was apaprently to stream forth from the mysterious boxes on the table was simply produced by dynamos in the usual way.

COMPRESSED AIR

AND EVERYTHING PNEUMATIC

Established 1896

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We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

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CONTENTS

THE NEW YORK PROBLEM

One of the easiest and one of the commonest things is the lamenting of our lack of foresight, or rather, the lack of it by others than ourselves. The shortsightedness thus so chronically deprecated really does not usually warrant either regret or reproach. We fail to see something far ahead just because it is not yet visible to us. Thus in the building of cities how much of destroying and rebuilding has to be done because of the shortsightedness of the original planners, and yet we must believe that they looked ahead to see as far as they could and successively did their best.

In this issue we speak of the completion and the putting into regular service of a portion of one of the new systems of tunnels and subways of Greater New York, to be used entirely for the local transportation of its citizens and near neighbors who do business, or who have their various interests to prosecute, within its borders. This tunnel system is only one of many works of similar character now being, or soon to be completed, and at once to be appropriated by the people and to be constantly relied upon as conveniences or necessities in the routine of their daily lives. If ever there was a call for foresight it surely must be now, to recognize and to prepare for the results of the new and permanent additions to our popular facilities of communication.

And yet who can tell what will be the new perplexities which will develop from our present mitigation of those which have been so long familiar? All these transportation facilities are designed first of all to relieve the congestion of population. The residence area of the city now so crowded, is to be indefinitely extended according to our growing needs so that all may have room to live and move in comfort and have good air to breathe.

That is good so far as it goes, and as far as we can see; but what if we are replacing —as we are—congestion by congestion? The new congestion of the business, or, rather, the office section of the city may not be as bad as the residence congestion, but still it develops its problems. The overcrowding of the office section of the city may not as yet be recognized, but the process which is distinctly leading towards it cannot long be ignored. The

facilities of transportation encourage the multiplication of the tall office buildings, and these develop continually the need of increased transportation facilities, each perhaps approximately keeping pace with the other, so that at the present outlook upon this phase of it no one is seriously worrying.

But with all the rushing and crowding and the means continually developing to make more of the same, the only ultimate result, nothing has been done, nothing apparently is being planned to be done to provide increased street area. The streets of down town New York were planned for perhaps one per cent. of the throngs of people and the merchandise and supplies which now have to traverse them, and it will not take long to double the traffic while the streets spread no wider. An alarmist might easily suggest great possibilities of danger which we need not particularize. Some sudden alarm of sufficient magnitude could precipitate a wild stampede in which lives by the hundred might be trampled out. There are several narrow streets now in which in the hours of the business day all wheeled vehicles should be prohibited.

Additional street accommodation is the apparently most urgent need of the near future, merely for the human traffic, while freight and supplies are also to be provided for, and this can only be found underground. At present additional subways coincident with the lines of the streets are the temporizing solution, not to be seriously objected to as far as they can afford relief; but it will be well to begin to consider the construction of deep sunk solid rock tunnels interfering with nothing in their construction and making short cuts in various necessary directions. These, of course, would necessitate a vast increase of elevator service, and there is no reason why the elevator might not be used for depths approximating the heights which it now commands.

THE REACH OF THE ROCK DRILL

The rock drill was originally devised for the specific purpose of perforating rock, usually for the insertion of explosives, and it would seem that its originators had never a thought of its employment for any other purpose than that of making holes in hard and brittle material. It was far enough from perfect in the beginning and many ingenious ones successively contributed to its improvement and to the securing of the high efficiency ultimately attained.

As happens to men so does it happen also to their instruments and agents. The achieving of valuable results leads invariably to the extension of the field of employment, and the doer of one thing well is before long promoted to the doing of many things often quite different from the first employment. First of all, the rock drill covered all the original requirements of rock drilling, being made in all sizes and with various peculiarities of detail to suit the different kinds of rock and the different conditions of working. Then besides the drilling of round holes in rock in any position and of any size and depth, and often under water for the deepening of navigable channels, it became a channeling machine in quite a different sense. It was arranged to cut channels or thin grooves in rock, and thus provided the working idea, and the means of carrying it out, for an entirely new and in fact a revolutionary system of stone quarrying.

The advantage thus secured and the economy of material and of labor permanently established by the modern system of stone quarrying are not sufficiently known or appreciated. We no longer attack a bed of rock in a careless and haphazard fashion, putting in holes without the semblance of system and then with heavy charges of evplosives knocking out shapeless chunks of rock of all conceivable sizes, some of them to be then laboriously shaped to whatever dimensions they may happen to come to, many to be entirely discarded and also vast quantities of material cut away in the shaping of those which could be made available. We now work carefully to dimensions in the act of quarrying. Usually there is a level or a vertical face to work to and then the piece to be produced is laid out and is cut to the size and shape required right in its native bed with little material wasted in the finishing, and the rock is in perfect shape and condition for other cuttings to follow.

Then there is the line of percussion coal-cutting machines, another adaptation and another extension of the employment of the rock drill. These also are of the channeling rather than the boring type, and they are making their own way, so that the proportion of machine-mined coal is constantly on the increase and production is cheapened.

The sheathing pile driver, another direct development of the rock drill, is in a way the simplest adaptation of the percussion principle. It applies force without the intervention of tools. It takes the place of the sledge and the man. It saves only labor, but nowhere, perhaps, has any device a chance to save in such a wholesale fashion. It will shower blows upon the end of a pile with such force and rapidity that it will do in a minute as much as a man would do in an hour, and never stops to rest. It thus by its facility makes a way for itself as few devices have had the opportunity to do, and it is sure of its job with the modern engineer.

And now we come around to a curious development, in that through the pneumatic tool the rock drill comes around to its original employment again. The so-called "hammer drill" which is now in highest favor with miners for "stoping work" is purely and simply a "pneumatic tool," the drill bit being forced constantly against the rock instead of reciprocating as in the "rock drill."

CORRESPONDENCE

The following comes to us from London:

Editor Compressed Air:

Possibly the following may amuse you, as it certainly did the writer. Happening some little time back into the Machinery Exhibition then being held at Olympia in this city, the writer noticed a rather extraordinary-looking rock drill, and stopped to ask the man in charge—who spoke with a broad Nottingham accent which an American typewriter can hardly be expected to reproduce—for some particulars.

"This 'ere is the Blankshire petrol drill, laad."

"Blankshire drill, is it? And what does the Blankshire drill do?"

"Ah'll tell thee what it's *a-goin'* to do, laad; it's a-goin' to knock out arl other drills on th' market, that's what it's a-goin' to do."

"And how it it going to do that?"

"'Cos it 'its 'arder and 'eavier than any on 'em, and runs cheaper."

"Sold any of them yet?"

"No, laad, there ain't been none of 'em sold yet; but that don't matter. It's the comin' drill, this is. Arl the others is a-goin'—Hingersolls and Rands and arl, arl of them's a-goin', and this 'ere drill is a-comin'. Compressed hair's a-goin' too—what's the good of buying a . . . hair-compressor when you can run a drill on petrol?"

"Bad news for the Compressed-air people, isn't it?"

"Can't 'lp their . . . troubles, laad; they're a-goin', they are."

"Well, I'd like to see your drill working; can't you start her up?"

"Ah'm sorry, laad, but Ah can't run her in 'ere—there's a lot of these 'ere people would be objecting to the smell of her, and the fumes of the petrol, and what not."

"Hum—then perhaps there's some hope for the compressed-air people after all. How are you going to manage about the fumes, and what not, when you get her running underground?"

At this point the demonstrator dropped his voice into a hoarse roar that was evidently meant to be a confidential whisper, and said, "Look 'ere, my laad; seems you know summat abaht these 'ere things, and Ah'll tell 'ee summat—this 'ere bloody drill ain't *meant* for underground!"

So that even when the Blankshire drill is perfected—if it ever is—there will still be some little field for compressed air.

A. B.

FLOW OF AIR IN PIPES

Editor of Compressed Air:

Mr. John J. Smith, in the August number of Compressed Air, criticised the formula for the flow of air in long tubes, which appeared in an article by me in the April number of your magazine, as "somewhat long and complicated." He quotes a formula by J. E. Johnson, Jr., published in the American Machinist, in July, 1899, which he considers simple. It is as follows:

$$P^2_1 - P^2_2 = \frac{KV^2l}{d^5}$$

I will show that this is only a special case of the fundamental formula for the flow of air in long pipes, first developed by Prof. Unwin as early as 1875. Referring to my article in Compressed Air, for April, 1907, p. 4411, the fundamental formula is as follows:

$$u^1 = \sqrt{427.86 \frac{T\ d}{f\ L} \frac{p^2_1 - p^2_2}{p^2_1}} \qquad (1)$$

in which u^1=Initial velocity in feet per second,
L=Length of pipe in feet,
T=Absolute temperature of the air in degrees Fahrenheit,
d=Diameter of the pipe in feet,
p1=Initial absolute pressure,
p2=Final absolute pressure,
=Coefficient of friction.

Transforming this equation.

$$p^2_1 - p^2_2 = \frac{u^2_1\ f\ L}{427.86 Td}$$

which may be written

$$p^2_1 - p^2_2 = \left|\frac{f\ c}{427.86\ T}\right| \left|\frac{p^2_1 u^2_1 d^4}{c}\right| \left|\frac{L}{d^5}\right| \qquad (3)$$

If the coefficient of friction be considered constant—which it is not, for all experiments of sufficient range and accuracy show that it varies with the diameter of the pipe, and probably varies with the velocity of the air —and if the temperature of the air be also considered constant—although we know that it may vary twenty per cent. or more—then

$$\frac{f\ c}{427.86\ T}$$

is constant and may be written=K.

If the volume of free air flowing per second be V, then

$$V = \frac{u_1\, n\, d^2}{4} \times \frac{p_1}{14.7}$$
$$= \frac{p_1\ u_1\ d^2}{\sqrt{c}}$$

and

$$V^2 = \frac{p^2_1\ u^2_1\ d^4}{c}$$

This value of V^2 is the second factor in equation (3).

Substituting we have

$$p^2_1 - p^2_2 = \frac{KV^2L}{d^5} \qquad (4)$$

which is the formula quoted by Mr. Smith. So long as K is treated as a constant, this formula can only be correct for one temperature, one size of pipe, and probably one air velocity.

Furthermore, this is not a convenient formula for most cases in ordinary practice, simple as it may seem at first sight. What we usually want to know is the loss of pressure due to friction of the pipe, or P1—P2. This formula gives the difference of the squares of the pressures. If we solve it for P1—P2, it does not appear so simple, thus:

$$P^2_1 - P^2_2 = \frac{KV^2L}{d^5}$$

$$P_2 = \sqrt{P^2_1 - \frac{KV^2L}{d^5}}$$

$$P_1 - P_2 = P_1 - \sqrt{P^2_1 - \frac{KV^2L}{d^5}}$$

A better formula is obtained by solving the fundamental equation (1) for P1—P2 as follows:

$$u_1 = \sqrt{427.86 \frac{T\ d}{f\ L} \frac{p^2_1 - p^2_2}{p^2_1}}$$

transforming

$$\frac{p^2_1 - p^2_2}{p^2_1} = \frac{u^2_1\ f\ L}{427.86\ Td}$$

$$p_2 = p_1 \sqrt{1 - \frac{u^2_1\ f\ L}{427.86\ Td}}$$

$$p_1 - p_2 = p_1 \left| 1 - \sqrt{1 - \frac{u^2_1\ f\ L}{427.86\ Td}} \right| \qquad (6)$$

This formula gives the loss of pressure directly, and takes into consideration the temperature of the air. The value of the coefficient can be found for any size pipe by Prof. Unwin's formula

$$f = .0027 \left| 1 + \frac{3}{10\ d} \right| \qquad (7)$$

made by numerous experimenters under a great variety of conditions to be quite accurate.

In conclusion, we fail to see the "extreme simplicity of the formula" quoted, and the credit of being the first to develop a correct and rational formula does not belong to Prof. Church, nor to Mr. Johnson, but to Prof. Unwin, as I pointed out in a former communication.

B. C. BATCHELLER.

[The following letter was received recently. For obvious reasons the name and address of the writer cannot at present be revealed.]

Editor Compressed Air:

I have recently gotten up a new invention, a self compressing air engine. I claim to have discovered a way by which air can be compressed for all power purposes without the aid of any other engine or the use of any coal. I have made drawings of my invention which will plainly show its outlines and the plan of its construction, so as to prove what I claim for it.

QUESTIONS AND ANSWERS

I. W. W., Queensville, Ont. *Q.*: Will you kindly tell me if there is a machine made which will convey the exhaust air from an air motor back into the tank from which the compressed air issues that actuates the motor? *A.*: There is no machine in existence which recompresses and returns the exhaust air to the receiver. Some perpetual motion cranks have suggested such a scheme, but it of course has come to nothing. It would be found that before the air was returned to the receiver at its former pressure more than one half of the original power would be lost, even if the motor did no other motoring.

NEW BOOKS

Hydraulic Engineering, by Gardner D. Hiscox, New York, The Norman W. Henley Publishing Company. 315 pages 6 x 9 inches, 300 illustrations and 36 tables. Price $4.00. This handsomely printed book is not a work of original research nor an exhaustive treatise upon hydraulics and engineering, but is really broader in its reach, as better indicated by its sub-title, it being " a treatise on the properties, power and resources of water for all purposes." It is a compilation of various information upon the general topic, much of it from sources not generally available. Two of the most important chapters in the book have to do with the Air-Lift and the Hydraulic Air Compressor.

TRADE PUBLICATIONS

Small Power Driven Air Compressors. Form E 36, Ingersoll Rand Company, New York, 48 pages 6 by 9 inches. This beautifully printed and illustrated catalog treats of an important and widely serviceable line of air compressors built by the company. Both horizontal and vertical machines are shown, the free air capacities covering from 500 cubic feet per minute down to 8 feet or less, while the pressures range from the lowest up to the highest ever practically employed. The drive may be either by belt, chain or gear, a constantly growing practice being the use of an electric motor mounted upon the machine base.

Sheet Pile Drivers, Form 478 Ingersoll Rand Company, New York, 12 pages 6 by 9 inches. Perhaps no other developement of the percussion rock drill is finding its field of employment so rapidly and so widely extending as the apparatus here discribed. The sheet pile driver is becoming one of the most important adjuncts of the modern engineer. It comes in for trench excavation, in sinking cofferdams, shaft sinking, building tunnel approaches, retaining walls, in canal work, in dam construction or wherever soft or moveable material is to be fastened either permanently or pending other operations. The pamphlet is full of information and suggestion.

ARTIFICIAL ICE

There are purists who object to the above as applied to real ice produced by artificial means. It happens to be the most convenient and we think also the most obvious designation, and it also has full dictionary warrant. We quote from the Standard Dictionary its first and principal definition of "artificial," as follows:

"Artificial, *a.* 1. Produced or composed by art rather than by nature, but of the same materials, and with the same or nearly the same result; manufactured: distinguished from *imitation;* as, *artificial* rubies (real rubies produced chemically); *artificial* ice."

The following quotation is given by the dictionary in illustration:

"The invention of *artificial* light has extended the available term of life. Draper Intell. Devel. Europe."

To give way to the unwarranted demands of the finical in language usage is to add to our cowardice and to their conceit, neither of which results is much to be desired.

WESTINGHOUSE ALL RIGHT

I have much pleasure in being able to notify the clients and other friends of The Westinghouse Machine Company that the receivers appointed October 23, 1907, by the Circuit Court of the United States for the western district of Pennsylvania, were on March 31, 1908, discharged by the same authority. All of the matters which made a temporary receivership expedient have been satisfactory arranged, and the Company's position is greatly strengthened from every standpoint.

All contracts made by the receivers for the sale of the Company's products, or for the purchase of materials or merchandise will be carried out as though made by the Company's own officers.

I take this occasion to announce the election of Mr. William H. Donner as the Vice President of the Company in direct responsible charge of all of its activities, and to give the assurance of the continuance and accentuation under Mr. Donner's administration of that steadfast policy whereby the clients of The Westinghouse Machine Company have become friends as well as customers.

GEO. WESTINGHOUSE,
President.

COMPRESSED AIR IN COAL WASHING

A coal washing plant consists, primarily, of a great tank full of water. Into the top of this tank is dumped powdered coal from the culm heaps. Mixed with the coal are large quantities of comminuted slate and other impurities, the presence of which makes the culm useless as fuel. While the coal itself is slightly heavier than water all the impurities are, fortunately, still heavier. On this fact is based the practical working of the washing tank. Left to itself the whole mass of powder would sink to the bottom of the tank, the particles of coal sinking considerably slower than the adulterants. At this point the trained scientific knowledge of the German inventor took command. From the bottom of the tank he discharged upward into the water small currents of compressed air of just sufficient strength to overcome the slight tendency of the coal particles to sink. So the coal is kept on the top, while the heavier bits of slate and other impurities still sink slowly down to the bottom. And a constant stream of water flowing across the top of the tank carries off into hoppers practically all the available fuel in the form of almost pure carbon.—*Saturday Evening Post.*

AUTHORS HAVE THEIR TROUBLES

In announcing the appearance of Vol. VII. of the annual "Cooper Handbook" Horace J. Stevens of Houghton, Michigan, says, with becoming frankness: "I deem it but fair to advise you that the revision of the book from Vol. VI. has not been complete. Owing to an unfortunate train of mishaps, including fire, Pasteur treatment on account of the bite of a rabid cat, blood-poison, three surgical operations and a number of minor mishaps, not helped by the panic and several printer's strikes, so much time was lost that it was impossible for me to revise the detailed mine descriptions in Chapter XV. of Vol. VI. Everything else, however, has been revised most thoroughly." Concluding his circular, Mr. Stevens says: "I am sorry to send out a book not entirely revised, but the loss of five month's time, about $20,000 in cash and a square foot of skin interfered with my previous plans."

TRANSPORTATIONOF LIQUID AIR

Liquid air has become in Europe a recognized article of merchandise, and a recent international convention to fix the conditions of transportation of various forms of merchandise has admitted liquid air as railway freight subject to the following conditions:

Liquid air is admitted as freight when contained in bottles, surrounded with felt and closed with a felt stopper allowing escape of the gas without producing high pressure in the interior or letting the liquid run out. This felt stopper must be so fixed that the bottle will not be emptied if it upsets. Each bottle, or several bottles together, must be protected against shocks by a crate of iron wire or some other similar recipient. These crates must be carried either in metal chests open at the top or protected by a grated or perforated cover, or in wooden cases marked "liquid air," "top," "bottom," "very fragile." These receptacles should contain no easily inflammable packing, such as sawdust, excelsior, peat, straw, or bran. Chests or cases must be quite tight below, up to a height so great that, in case of

breakage of the bottles, no liquid can run out. The cases must be placed in the cars in such a manner that they can not fall or be upset, and so that the bottles stand upright and can not be injured by other freight. No substance easily inflammable in small pieces or in the liquid state may be packed in the immediate neighborhood of the liquid air. Instead of glass double-walled bottles, covered with felt, other recipients may be employed, always on condition that they be so protected that they can become coated neither with dew nor with frost. If these receptacles are strong enough and can stand upright, they need not be surrounded by wire crates or be protected in any other way.—Translation made for *The Literary Digest.*

$25,000 PRIZES FOR A ROCK DRILL CONTEST

The recent rock drill contest conducted by *South African Mines,* and the continuing demand for better rock drill efficiencies and conveniences, has stimulated the Transvaal Government, in connection with the Johannesburg Chamber of Mines to announce another contest, allowing about a year for preparation, for the best practical small rock drill. Two prizes are to be offered, one of £4,000 and one of £1,000, the conditions of the contest and all details to be settled by a committee of engineers nominated jointly by the Government and the Chamber. Not less than £250 additional will be available for the men who operate the drills. It is understood that the trials will be severe and protracted, but as near actual working conditions as possible.

Vacuum cleaning for household use has been rapidly on the increase in the past year or two. One can now find on the market electric motor driven apparatus all the way from a light portable apparatus weighing only 70 lb., using a one-sixth horse-power motor and costing about $125, up to large stationary plants employing motors from 5 horse-power up, and costing many hundreds of dollars. The machines range all the way from those producing a very small vacuum and moving a considerable volume of air up to others maintaining 15 in. vacuum, which will pull the dust clear through an ordinary rug.

SPRING MEETING OF THE MECHANICAL ENGINEERS

The Semi-Annual Meeting of The American Society of Mechanical Engineers will be held in Detroit, Michigan, June 23-26. Among the papers to be presented at this session are "A Method of Cleaning Gas Conduits," by W. D. Mount; "A Method of Checking Conical Pistons for Stress," by Prof. George H. Shepard; "Clutches" with special reference to automobile clutches, by H. Souther; "Horse-Power, Friction Losses, and Efficiencies of Gas and Oil Engines," by Prof. L. S. Marks; "Some Pitot Tube Studies," by Prof. W. D. Gregory; "The Thermal Properties of Superheated Steam," by Prof. R. C. H. Heck; "A Journal Friction Measuring Machine," by Henry Hess; "A By-Product Coke Oven," by W. H. Blauvelt; "Tests of Some High Speed Steam Engines," by F. W. Dean. There will be a symposium upon machinery for conveying materials, with papers by several authorities. The Society for the Promotion of Engineering Education and the Society of Automobile Engineers will also hold their annual meeting in Detroit at this time, which will enable members of each Society to participate in the sessions of the other.

NOTES.

AIR LIFT WITH ELECTRIC MOTOR

The air lift has never had any great claims for economy made for it, but it certainly eliminates much of the uncertainty of service and expense of repairs to apparatus which operates deep in a well, because all of the moving machinery is entirely outside of the well. Assuming that a central station company is able to do all of its pumping from a well at times when it has ample engine and generator capacity, the question of the inefficiency of the air lift in a small central station need not cause much concern. If the air compressor is operated either by a belt from an engine used to drive a generator, or by a motor from the generator, it will usually cause a surprisingly small increase in the coal consumption. The reason for this is that many of the fixed losses in the engine and boiler plant are so large on light loads that a small addition to

the load does not make a proportionate increase in the coal bill.

* * * * *

In a small plant, where it is desirable to keep the investment down, the air compressor, which can so easily be adapted either to motor or engine drive, has strong claims for recognition.—*Electrical World.*

FOR RAISING SUNKEN OR STRANDED SHIPS

A new system employing compressed air for raising sunken ships is named the Fearon. The method by which the air vessels are fixed to a ship is its most striking feature. To begin operations two or three air vessels are fixed to the forward portion of the submerged boat, and when these are inflated that end rises so that divers can begin operations. They fix a tackle, consisting of wire rope, rings, etc., which covers the sides of the ship with a network to which air vessels can then be attached. These are then inflated and the ship rises. This system is only applicable where a diver can work. The air vessels are made of canvas and india-rubber or "diver's" cloth." By this arrangement a vessel may be provided with a complete air belt of any required capacity.

A CLYDE SHIPBUIDER ON PNEUMATIC TOOLS

Mr. John Ward, president of the Scottish Institution of Engineers and Shipbuilders, in a recent address said that in the open market for new ships the most dreadful competition that had ever been seen had taken place within the last year or eighteen month, and was still going on. Shipbuilders openly acknowledged that, so far from profit being an object, it had disappeared into the background, and that now they looked upon it as a necessity to keep their places going at any cost. And while this was so at home, Germany and America were rapidly pulling up on them, and had produced some fine work during the past year. In the latter country, which he had visited, pneumatic tools for calking, cutting and riveting were in general use, and the results of their adoption were the lessening of the heavy manual labor and substantial increases of the workmen's earnings, together with improved workmanship. On this side of the Atlantic they had had experience of the calking and cutting tools; but, from some inexplicable reason, a dead-set had been made against them by the men for riveting. He was certain were they given an honest trial there would be a great advantage.

NOTES

The new British turbine torpedo boat destroyer Tartar on her recent trial attained a speed of 35.92 knots per hour—41.39 miles.

Lester A. Pelton, inventor of the Pelton waterwheel, died at Oakland, California, March 15th, 78 years old. Mr. Pelton was born in Ohio and went to California in the rush of '49. His wheel was first used in gold mining operations in California, and its name has become typical of impulse wheels in general, especially those using great pressures.

"High pressure air pipe lines, though smaller in diameter, require more care to keep them tight than lines for low pressure." A little more care may be required when connecting pipes for high pressure to make sure that they are tight, but practically no care is ordinarily required to *keep* them tight. If leaks exist, however, they may be expected always to enlarge, the process continuing without limit.

The old Port Royal mine of the Pittsburg Coal Co. is to be emptied of the water that has filled it for years. Three ten-inch holes are being drilled from the surface to the interior of the mine, a distance of 365 feet, and in each will be placed a six-inch discharge pipe. Each of these discharge pipes will be capable of discharging 2,000,000 gallons of water per day by the air lift process, all of which will be emptied into the Youghiogheny river. When the drill penetrated the old workings, the pressure of the gas threw the water as high as the derrick.

Karl Lanz, a merchant of Mannheim, has handed over to the German Aeroplane Club $10,000 to found a prize to be contested for by aeroplanes heavier than air. The aeroplanes must be constructed by German builders in Germany, and be propelled by home-made motors. The competition will be held over the Tempelhof parade ground. Herr Lanz has given also $2,500 to help poor German aeroplane inventors.

In order to ascertain what really takes place when coal is submitted to a moderate rise of temperature with limited access of air in closed vessels, Dr. Habermann some time ago carried out a series of experiments at Munich with different kinds of coal, which were broken up into small fragments about the size of peas, and kept for eight days in iron retorts heated to a temperature of 142 degs. Cent. (287 F.); two 1¼ air pipes were inserted near the bottom of the retort, but there was no other opening. Some kinds of coal heated rapidly and ultimately reached a temperature of 350 degs. Cent. (662 F.), but with other descriptions of coal the rise in temperature was less marked.

Gas in a tunnel of the Pennsylvania Railroad under the City of Baltimore, in March, caused the death of four workmen by suffocation and rendered unconscious a score of others who revived. The tunnel is the most northerly one of those carrying the allied Pennsylvania lines under the city. It is more than half a mile long, for two track travel, being 27 feet wide and 22 feet above the rail. There was a 15 foot electric driven ventilating fan near the middle of the tunnel, but two or three days before the accident this fan was stopped for repairs. When the men were sent in to perform necessary tunnel work the gas had accumulated to such an extent that the men were overcome as above stated.

The famous Iron Mountain tunnel has recently been completed, and the unwatering of the old Iron Mountain mine in western Montana by means of drainage through the tunnel has begun. The mine shaft had filled with water to a depth of 900 feet above the point where it was tapped by the tunnel. The tunnel will take care of the water by the natural gravity system above the 1,700-foot level of the mine and below that level it will be pumped to the tunnel and allowed to flow out. The completion of the enterprise will effect a great saving to the company in the operation of the mine. The distance from the mouth of the tunnel to where it intersects the shaft is 5,560 feet, or more than a mile. The work was begun March 21, 1906. After the mine is unwatered mining operations upon an extensive scale will be commenced.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MARCH 3.

880,570. COMPRESSED-AIR LIQUID-ELEVATOR. JOHN H. PHILLIPS, Pottsville, Pa.

880,595. PNEUMATIC-DESPATCH-TUBE APPARATUS. CHARLES F. STODDARD, Boston, Mass.

880,607. PNEUMATIC MOTOR FOR ADDING MACHINES. CHARLES WALES, Detroit, Mich.

880,698. ACETYLENE-GAS GENERATOR. HARVEY S. STONER and BURTON STONER, Massillon, Ohio.

880,731. AIR-COMPRESSOR. GEORGE F. HALL, Jersey City, and BENJAMIN ALBERTSON, Mantoloking, N. J.

880,746. AIR-PUMP. JOSEPH B. MERIAM, Cleveland, Ohio.

880,763. ACETYLENE-GAS GENERATOR. HARVEY S. STONER and BURTON STONER, Massillon, Ohio.

880,815. STORED - PRESSURE MOTOR-STARTING DEVICE. EDWARD P. NOYES, Winchester, Mass.

880,824. VALVE MECHANISM FOR ENGINES AND COMPRESSOR. SIDNEY A. REEVE, Worcester, Mass.

880,881. PNEUMATIC AND OTHER DRILL. MARTIN HARDSOCG, Ottumwa, Iowa.

1. A shank for a pneumatic tool, formed of a base, a curved wing extending from each side edge of the base on one face thereof, with the abutting ends of the curved wings in contact and forming, with the base, a passage longitudinally of the shank, a central rib on the base, and a curved wing on each side of the center of the base, with the abutting edges of the wings in contact and forming, with the base, a passage, each passage extending longitudinally of the shank and one passage furnishing a means for admitting a cooling medium to the cutting end of the tool, and the other passage furnishing a means for withdrawing dust and fine particles from around the cutting end of the tool, substantially as described.

881,040. COMPRESSOR FOR INTERNAL-COMBUSTION ENGINES. HARRY W. ADAMS, Fargo, N. D.

881,059. ROCK-DRILL. HENRY J. COOK, Ottumwa, Iowa.

1. In a rock-drill, a casing having a tubular drill stem mounted at one end, an air-propelled hammer, a striking-head mounted between the hammer and the drill-stem having a hole therein that registers with the hole in the drill-stem, and a hose connection secured to said striking-head and communicating with the hole therein, substantially as shown and described.

MARCH 10.

881,116. AIR OR VACUUM PUMP. WILLS M. FLEMING, Holyoke, Mass.
881,176. APPARATUS FOR THE LIQUEFACTION OF AIR. GEORGES CLAUDE, Paris, France.
881,195. SIGHT-GLASS AND SEPARATOR FOR PNEUMATIC RENOVATORS. WILLIAM F. MOUGHLER, Toledo, Ohio.
881,327. AIR-SHIP. JOHN W. MONTGOMERY, Columbus, Ohio.
881,351. VACUUM-PAN. ALONZO P. SMITH, Philadelphia, Pa.
881,431. APPARATUS FOR CARBURETING AIR. CHARLES L. MEYER and NICHOLAS P. HICKEY, Detroit, Mich.
881,498. AIR-COMPRESSOR. JOHN STURGESS, Troy, N. Y.
881,516. ANNULAR VALVE FOR COMPRESSORS, BLOWING-ENGINES, AND THE LIKE. JEAN A. WILLAREDT, Brussels, Belgium.
881,548. AIR-EXHAUSTING LIQUID-SUPPLY APPARATUS. CHARLES A. CLAFLIN, Medford, Mass.
881,836. WING FOR FLYING-MACHINES. EVERETT E. WARNER, Hartford, Conn.
881,837. AEROPLANE. GUSTAVE WHITEHEAD, Bridgeport, Conn.
881,885. AIR MOTOR. LEWIS B. DOMAN, Elbridge, N. Y.

MARCH 17.

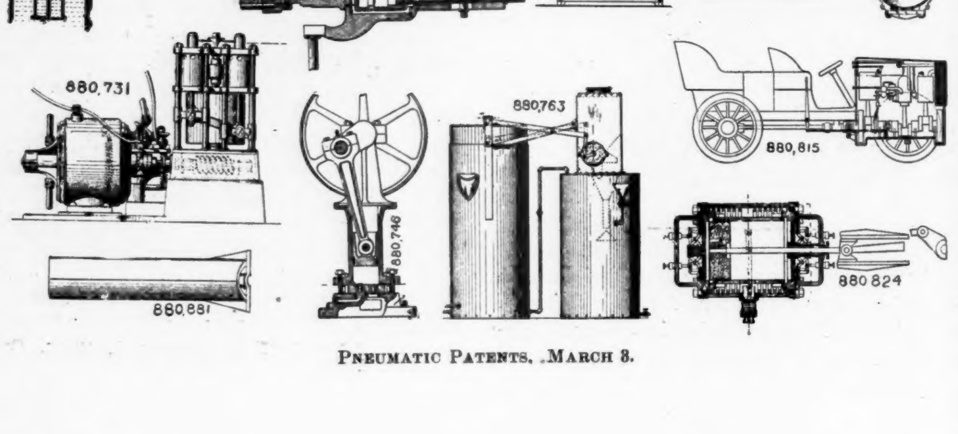
882,085. FLUID-PRESSURE GENERATOR. MARION WARREN, Rochester, N. Y.
882,189. FLYING-MACHINE. EDWIN L. DRAKE, Winchester, Tenn.
882,215. TIRE-PUMP. WILLIAM S. STAPLEY, Bridgeport, Conn.
882,219. VENTILATING SYSTEM FOR ROOMS AND THE LIKE. SERGIUS TIMOCHOWITSCH, Moscow, Russia.

1. In a ventilating system for rooms and the like, the combination of a chamber located directly beneath the ceiling of the room and having its under side closed by a filtering medium, air supply ways connecting said chamber with the outer air, air exhaust ways separated from said chamber and leading from the top of the room to connect the room with the outer air, and fans in said supply ways and exhaust ways.

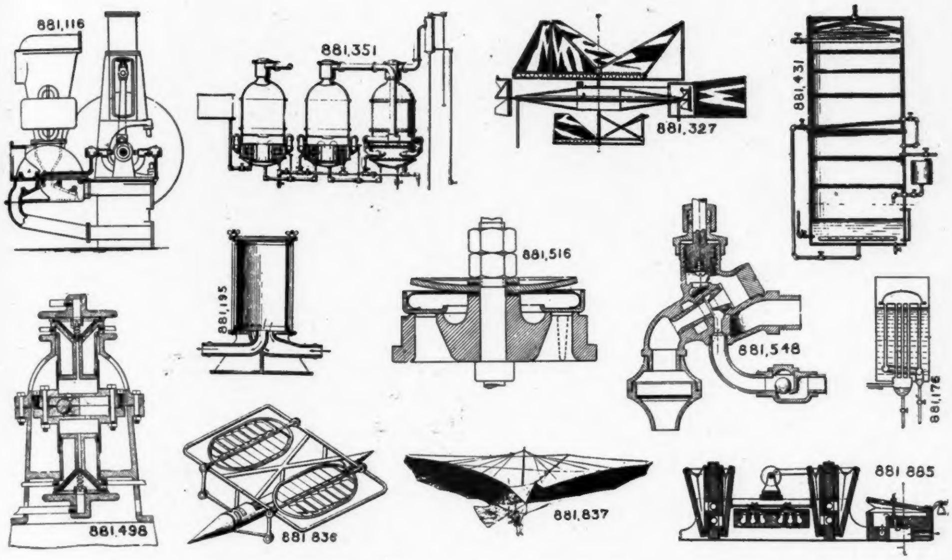
882,259. PNEUMATIC CARVING-DRILL. HERMAN MEYER, St. Louis, Mo.
882,312. APPARATUS FOR FACILITATING THE PUTTING ON OF INDIA-RUBBER GLOVES. CAREL A. HOEFFTCKE, London, England.

1. An apparatus for facilitating the application of India rubber gloves to the hands of the wearer, consisting of a chamber having an annular opening at the top sufficiently large for the insertion of the hand, an annular collar around said top opening over which the wrist of the glove is stretched, so that it depends into said chamber and forms a closure therefor, means for securing the wrist portion of the glove to said collar, and means for temporarily reducing the pressure of air in said chamber, whereby the glove is stretched to admit the wearers hand, substantially as set forth.

882,338. REGULATOR FOR COMPRESSORS. FRED E. NORTON and IRVING H. REYNOLDS, Youngstown, Ohio.
882,350. SEAL FOR PIPE-JOINTS. BERNARD F. SHAUGHNESSY, Pittsburg, Pa.
882,406. AUTOMATIC COUPLING FOR AIR-BRAKE SYSTEMS. BENJAMIN J. MORGAN, Bevier, Mo.
882,435. FLYING - MACHINE. THOMAS J. WHALEN, Middlebrook, Va.
882,457. FLYING-MACHINE. EMIL R. ERNST, Warrenpoint, N. J.
882,477. CENTRIFUGAL SUCTION-MACHINE. CHRISTIAN NEUMANN, St. Louis, Mo.
882,478. PRESSURE-BLOWER. CHRISTIAN NEUMANN, St. Louis, Mo.
882,503. AIR-HOSE COUPLING. WALTER W. KILPATRICK, Atlanta, Ga.
882,528. GAS-GENERATOR. FRED MEARS.



PNEUMATIC PATENTS, MARCH 8.



PNEUMATIC PATENTS, MARCH 10.

Minneapolis, and JOSEPH CRAIG, Princeton, Minn.

1. In a generator for producing compounds of nitrogen and oxygen, the combination with a retort and a generating rod, of a holder for said rod, which holder is adjustably suspended within the retort and supports said rods with freedom for the gravity feed of the rod as it is consumed by the acid, substantially as described.

882,532. PNEUMATICALLY-OPERATED MASSAGE APPARATUS. THOMAS A. MCCALL, Xenia, Ohio.

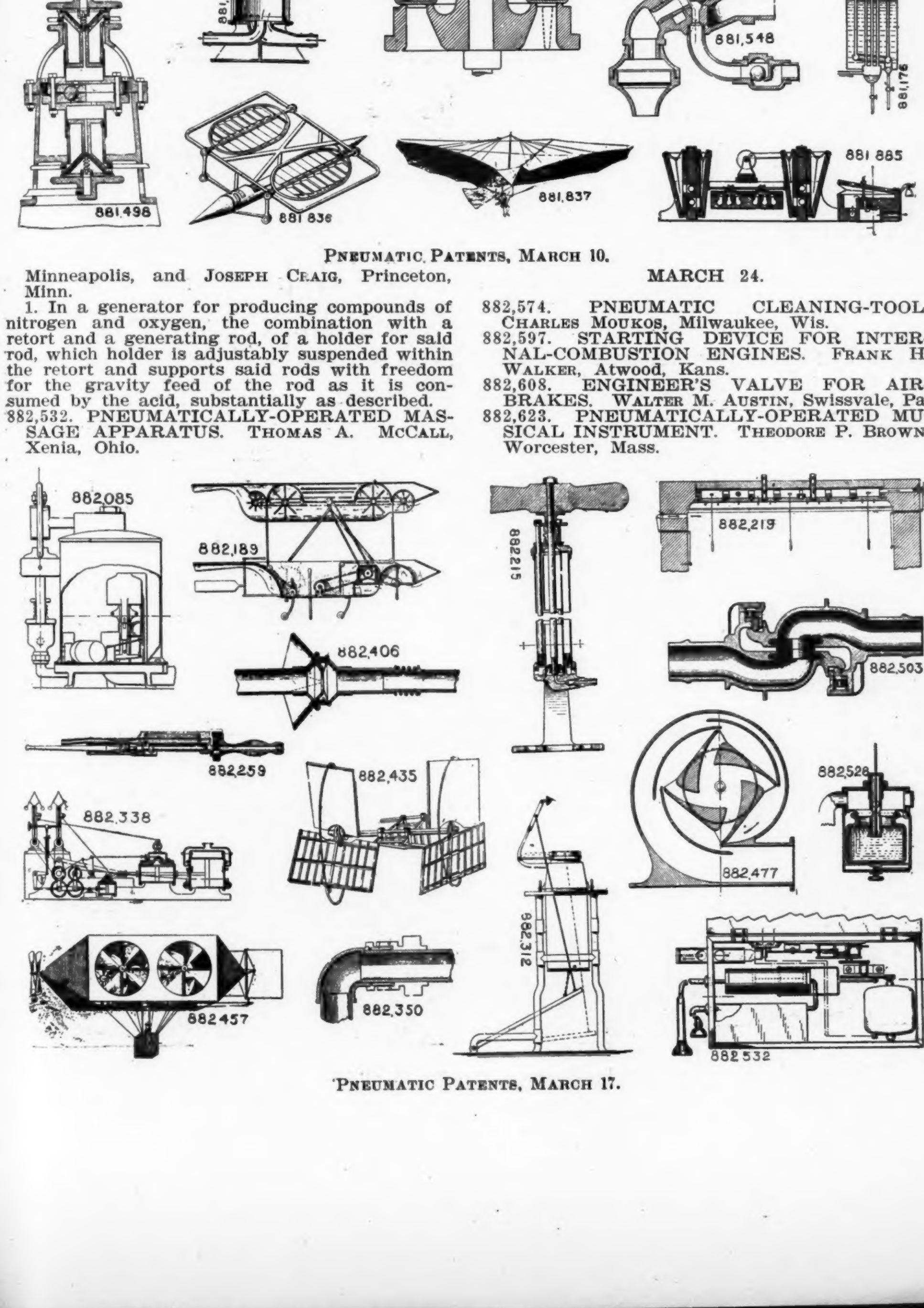
MARCH 24.

882,574. PNEUMATIC CLEANING-TOOL. CHARLES MOUKOS, Milwaukee, Wis.

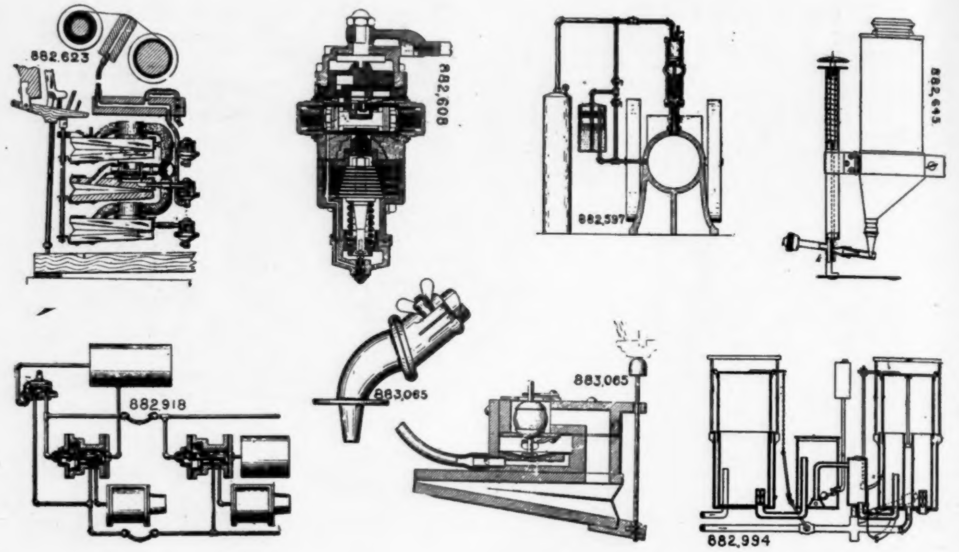
882,597. STARTING DEVICE FOR INTERNAL-COMBUSTION ENGINES. FRANK H. WALKER, Atwood, Kans.

882,608. ENGINEER'S VALVE FOR AIR-BRAKES. WALTER M. AUSTIN, Swissvale, Pa.

882,623. PNEUMATICALLY-OPERATED MUSICAL INSTRUMENT. THEODORE P. BROWN, Worcester, Mass.



PNEUMATIC PATENTS, MARCH 17.

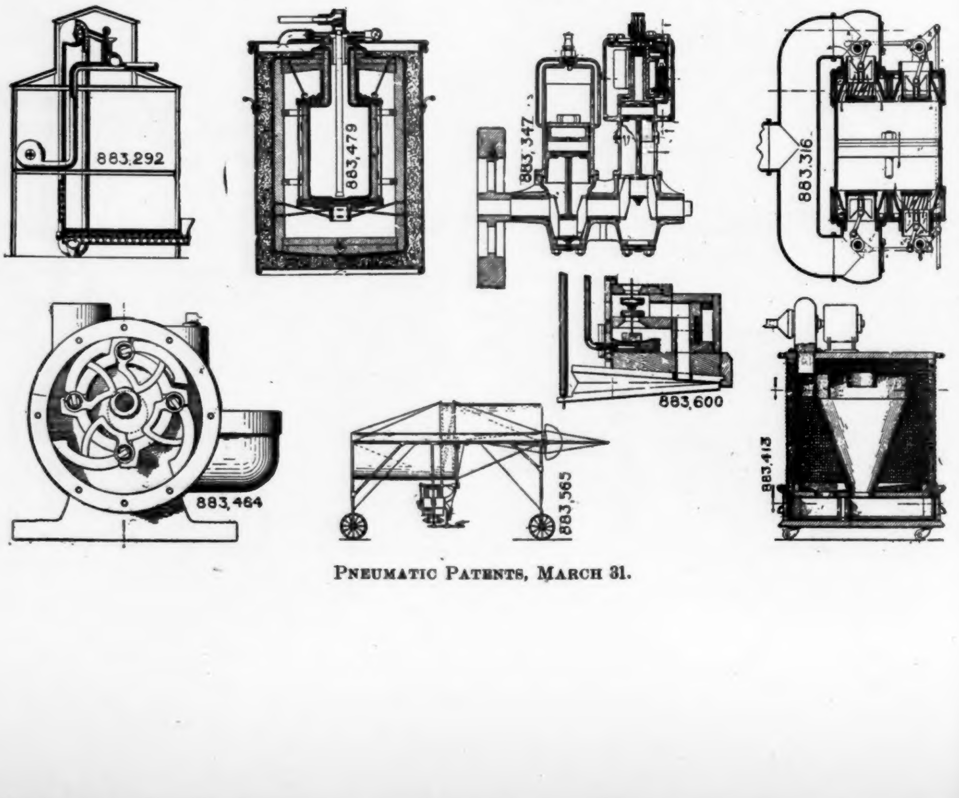


PNEUMATIC PATENTS, MARCH 24.

882,645. HAND-OPERATED SAND-BLAST. HANS MIKOREY, Schoneberg, near Berlin, Germany.
882,918. AIR-BRAKE. WALTER V. TURNER, Wilkinsburg, Pa.
882,994. AIR-FORCING MEANS FOR A GAS-GENERATOR. GEORGE P. CAMPBELL and FRANK H. RINGEMANN, Cincinnati, Ohio.
883,065. PNEUMATIC-VALVE MECHANISM. THEODORE VRANA and BRETISLAV SCHIBA, New New York, N. Y.

MARCH 31.

883,292. PNUEMATIC GRAIN-CONVEYER. WILLIAM F. CARLTON, Advance, Mo.
883,316. BLOWING-ENGINE. PATRICK H. KANE, Buffalo, N. Y.
883,347. COMPRESSOR. EDMUND W. ROBERTS, Clyde, Ohio.
883,413. PNEUMATIC DUST-COLLECTOR. WILLIAM F. MAHONEY, Washington, D. C.
883,464. BLOWER. GEORGE W. LEIMAN and WILLIAM H. LEIMAN, New York, N. Y.
883,479. INSULATED CONTAINER FOR LIQUID AIR, &c. JAMES F. PLACE, Glenridge, N. J.
883,565. AERO-TUBE. WILTJE PARS, Seattle, Wash.
883,600. PNEUMATIC VALVE-ACTION. JOSEPH WIESER, New York, N. Y.



PNEUMATIC PATENTS, MARCH 31.